A Socioeconomic Impact Assessment of the Automated Information Directory System (AIDS) at the Washington Metropolitan Area Transit Authority (WMATA)

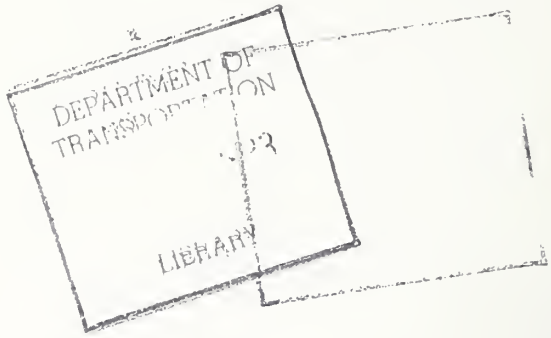
R.O. Phillips

Wilson Hill Associates, Inc.
140 Federal Street
Boston MA 02110

April 1983
Final Report

U.S. Department of Transportation
Urban Mass Transportation Administration

Office of Technical Assistance
Office of Methods and Support
Washington DC 20590



NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

NOTICE

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UMTA-MA-06-0126-83-1		

4. Title and Subtitle
A SOCIOECONOMIC IMPACT ASSESSMENT OF THE AUTOMATED INFORMATION DIRECTORY SYSTEM (AIDS) AT THE WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY (WMATA)

5. Report Date
April 1983

6. Performing Organization Code
DTS-64

8. Performing Organization Report No.
DOT-TSC-UMTA-83-20

7. Author(s)
Robert O. Phillips

9. Performing Organization Name and Address
Wilson Hill Associates, Inc.*
140 Federal Street
Boston, MA 02110

10. Work Unit No. (TRAIS)
UM364/R3674

11. Contract or Grant No.
DTRS-57-81-00054

13. Type of Report and Period Covered
Final Report
Nov. 1980-Dec. 1981

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Urban Mass Transportation Administration
Office of Technical Assistance
Office of Methods and Support
Washington DC 20590

14. Sponsoring Agency Code
URT-42

15. Supplementary Notes
*Under contract to: U.S. Department of Transportation
Research and Special Programs Administration
Transportation Systems Center
Cambridge MA 02142

16. Abstract

This report documents a series of data collection efforts carried out by Wilson Hill Associates, Inc., in support of UMTA's Impact Assessment Program. The focus of these efforts was the Automated Transit Information System (ATIS) deployment in the Telephone Information Section of the Office of Marketing at the Washington, DC, Metropolitan Area Transit Authority (WMATA). This system, known as the Automated Information Directory System (AIDS), was implemented in the interest of making WMATA's telephone marketing services more efficient through automation of data retrieval functions traditionally performed manually by telephone information operators, or agents. Key parameters in this assessment were measures of information agent productivity, system response accuracy, agent job satisfaction and economic benefits of reduced agent training periods, centralized data base updating, and use of system data bases by other transit system departments.

Data collected both before and after the AIDS implementation failed to disclose a significant productivity improvement in terms of percent of total incoming calls answered, although this may be a spurious result attributable to uncontrolled factors at the time the data was collected. Further testing indicated that AIDS can substantially improve individual operator performance and the reliability of information provided. Furthermore, the computerized AIDS data base is a valuable resource which can be used by WMATA for revenue forecasting, bus stop information displays, and better matching of service and demand. The geographic portion of the data base is also suitable for other metropolitan uses.

17. Key Words	18. Distribution Statement
Automated Transit Information Systems (ATIS), Data Base Systems, Transit Telephone Information Services, Transit System Marketing, Washington Metropolitan Area Transit Authority (WMATA)	DOCUMENT IS AVAILABLE TO THE U.S. PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	108	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

METRIC CONVERSION FACTORS

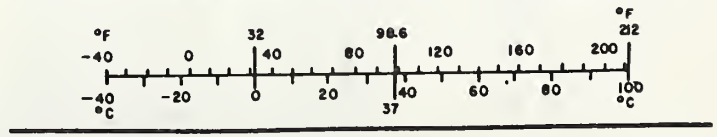
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	squsrs inches	6.5	squsrs centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	squsre yards	0.8	square meters	m^2
mi^2	squsre miles	2.6	squars kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	tesspoons	5	milliliters	ml
Tbsp	teblespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	querts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius tempersture	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	milss	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	squars miles	mi^2
ha	hectarss (10,000 m^2)	2.5	scres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius tempersture	9/5 (then add 32)	Fahrenheit tempersture	°F



PREFACE

This report has been prepared by Wilson Hill Associates, Inc. for the Transportation Systems Center's (TSC) Service Assessment Division in support of the Urban Mass Transportation Administration's (UMTA) Impact Assessment Program sponsored by The Office of Methods and Support. UMTA is cooperating with and supporting the transit industry's efforts to improve the productivity and quality of telephone/information marketing services to the public. The principal focus of this support is on the sponsorship of Automated Transit Information Systems (ATIS) technology demonstrations. TSC, in support of UMTA's program, is evaluating ATIS demonstrations in Los Angeles and Washington, D.C. This report, an interim product in an ongoing ATIS impact assessment program, documents the Washington D.C. demonstration.

While specifically intended for the information of TSC and the management staff of the Washington Metropolitan Area Transit Authority, this report will also be of interest to others in the transit public information/marketing community who wish to study applications of computer-aided information retrieval systems.

The evaluations described in this report were conducted under the management of Mr. Robert Furniss and Mr. Robert Phillips, Project Managers for Wilson Hill Associates. Mr. Furniss was Project Manager through February, 1981 when he left Wilson Hill. On this date, Mr. Robert Phillips assumed project management responsibilities. For the Washington D.C. evaluation, Mr. Furniss directed most "pre-implementation" data collection activities, while Mr. Phillips managed the project through the "post-implementation" phase and wrote this evaluation report.

Much gratitude is expressed by the author to those WMATA personnel involved in telephone information services, particularly to Mr. Michael Noonchester, Mr. Michael Munkasey, and Mrs. Frances Gray, for their cooperation throughout the project. In addition, special thanks go to Mr. I. Michael Wolfe and Dr. Arthur Priver, TSC technical contract monitors, for their encouragement and managerial support.

CONTENTS

CONTENTS, CONTINUED

LIST OF TABLES

LIST OF TABLES, CONTINUED

LIST OF TABLES, CONTINUED

LIST OF ILLUSTRATIONS

EXECUTIVE SUMMARY

A telephone information service is one tool frequently employed by transit authorities as part of their overall public marketing strategy. Such a telephone information service has several distinct advantages as compared with alternative media such as printed service schedules or maps. First, it is easy to use and is accessible to a substantial portion of the transit-riding public. Second, it can be frequently updated to reflect changes in routes and schedules, breakdowns, special services, etc. Finally, and most importantly, it can be personalized to meet the needs of the individual customer.

At most transit authorities, telephone information operators employed by the authority have traditionally provided information to callers by referencing large indexed volumes of schedules, headway sheets, maps, route descriptions, etc. located at their work stations. This process can be time-consuming, tedious, and heavily labor-intensive. It is therefore quite costly for transit properties to maintain a telephone information operation in proportion to consumer demand for this information. In most instances, tradeoffs are made in favor of cost reductions which result in information service shortfalls of up to 30 percent during peak demand periods.

The Urban Mass Transportation Administration (UMTA) has over the past eight years been implementing a research and development program aimed at determining the feasibility of applying state-of-the-art computer technology to the provision of transit information. This program is referred to as the Automated Transit Information System (ATIS) program. Its objective is the innovative introduction of automation to the job of the telephone information operator in order to reduce costs, increase productivity, or improve service provided.

Recent advances in computer technology have enhanced the potential for cost-effective automation of data retrieval functions routinely performed by transit telephone information operators. Certain aspects of these functions make them well-suited for computer implementation. First, they are highly repetitive; most caller requests can be classified into four distinct types, each requiring consultation of specific reference data. Second, they require considerable memorization by the operator of service area geography, routes, schedules, etc. These characteristics can be mapped onto a coordinate grid and stored in the computer's memory. Third, information operators often optimize certain trip parameters for the caller (such as travel time or walking distance). A computer's capability to repeatedly compare alternatives can be exploited by translating operator comparison/optimization logic into logical computer program routines. Fourth, it is important that operator-supplied information exhibit a high degree of consistency. Computer programming logic ensures that the same query will always elicit the same response. Finally, due to high caller demand, information operators must work as rapidly as possible. The high speed calculating characteristics of a computer guarantee that automated processing of a given caller request will involve a much more thorough investigation of alternative responses than time limitations would permit using traditional manual retrieval methods.

Thus, the application of computer logic, memory and speed to these data retrieval functions raises the potential for improving an information operator's job in a variety of ways. These improvements could also produce benefits not only for the agents, but also for the transit authority management and the general public as well. Among these hypothesized benefits are:

- improved productivity in terms of agent calls per hour due to faster data retrieval;
- increased reliability and consistency of agent responses;
- a reduction in training time for new agents;
- improved capability to rapidly incorporate changes in transit agent reference data;
- enhancement of the agent's overall job satisfaction;
- expanded capability to gather statistics concerning individual agent and Information Section performance; and
- use of the transit system data base by other departments as a planning source.

Computer assisted data retrieval changes the information agent's job in a variety of ways. ATIS operation involves an agent's retrieving desired information through the use of a remote interactive computer terminal located at the agent's work station. The system is activated by the agent's entering caller query data on the keyboard and selecting the proper functions to produce the desired response. Following processing, which takes a matter of seconds, the computer responds with several appropriate alternatives. The agent then evaluates these responses in light of the query and selects the one best suited to the caller's needs.

This report documents a number of data collection and analysis efforts carried out by Wilson Hill Associates, Inc. for the U.S. Department of Transportation's Transportation Systems Center (TSC), Service Assessment Division. The TSC, as part of UMTA's Impact Assessment Program, is evaluating ATIS demonstration deployments in Washington, D.C. and in Los Angeles. The ATIS at the Washington Metropolitan Area Transit Authority (WMATA), known as the Automated Information Directory System (AIDS), is the subject of this evaluation report.

The Information Section of the Office of Marketing at WMATA is one of the largest telephone transit marketing centers in the nation and a prime candidate for ATIS implementation. Its 57 operators answer caller queries about transit service in three shifts, 18 hours a day, 365 days a year. On an average day between 5,000 and 10,000 calls are received by the Section. During peak demand periods, operators answer over 800 calls per hour; for years the WMATA telephone information number has been the busiest one in the Washington, D.C., Metropolitan area. Despite this effort, over 30% of all incoming calls are "lost" in peak periods; that is, callers placed in a holding queue by telephone answering equipment hang up before ever reaching an operator or receiving any information.

In undertaking this evaluation, Wilson Hill's objectives were twofold: first, to ascertain the effects of automation on agent performance and job satisfaction; and second, to determine the extent to which the system demonstration had achieved its intended benefits, as stated above.

In this effort, large amounts of quantitative and qualitative data were collected. Because this evaluation began while AIDS was still undergoing design checkout and system acceptance testing, most data were collected using a "before-and-after" methodology for comparison purposes. Quantitative data included statistics on caller and Information Section performance as recorded by the Automatic Call Distribution System (which keeps track of incoming calls), performance data of various types collected by evaluation personnel monitoring the operators at their work stations, and summaries of all computer transactions as recorded on the AIDS Daily Log File. Qualitative data were gathered through opinion surveys administered to the information agents both before and after the system implementation and through interviews with WMATA management and supervisory personnel, as well as with the agents themselves.

A careful review of these quantitative and qualitative data leads to generally positive findings concerning the overall performance of the AIDS in its demonstration. While the implementation process was somewhat extended due to a variety of unforeseen problems, the data collected show that the system is, in most cases, currently functioning as originally intended and even exceeding expectations in some areas. System performance in achieving a number of different implementation objectives is discussed in the following sections.

- Agent Productivity: Data collected during the course of the evaluation lead to conflicting conclusions regarding system influences on operator productivity. Agents were evenly divided on the after-implementation questionnaire regarding AIDS' influence on call counts, and a number of them complained about "slowness" of system response. Furthermore, telephone answering equipment data revealed a decrease overall in Information Section productivity in the post-implementation period. In contrast, agents were almost unanimous in the opinion that AIDS made their jobs easier, and routine performance tests conducted by Information Section management reveal that operators using AIDS are capable of answering calls at the rate of 30 to 40 per hour, a 30% increase over their normal manual speed.

  WMATA supervisory and management personnel were able to generally explain the causes underlying these conflicting results. It appears that with current system function configurations and response speed, questions about schedules are still handled fastest manually; this fact is supported by call monitoring data. Schedule questions make up about one-quarter of all incoming calls. Thus, agents who use the computer for nearly every call are actually less productive than

those who use it more selectively. Varying agent experience levels are a factor contributing to post-implementation productivity declines since newer agents tend to rely on computer or manual references more than their more experienced counterparts, who rely more on memory. The Information Section experienced considerable turnover during system implementation. Supervisory personnel indicated that very experienced operators (having 10 or more years on the job) are able to answer up to 75% of their calls from memory. These operators tend to use AIDS only for calls requiring construction of long or complex itineraries. This job is tedious, but is well-suited to the computer's abilities to repeat pre-programmed comparisons and to optimize certain variables. It is not surprising, then, that more experienced operators would feel that using the computer would slow them down in most instances, but would still be of the opinion that it made their job easier (for the more complex queries).

Supervisory personnel indicated that they were initially discouraged by agent call counts following AIDS training. When they made it clear to the agents that using AIDS was not necessarily the most useful nor the most efficient way to respond to every call, productivity increased considerably, usually to levels above the previous average for manual data retrieval. Management and supervisors both felt that a 50-50 balance between computer and manual data retrieval produced the highest overall call count for the average agent. Call monitoring results show that this balance has not yet been achieved; agents are using AIDS for approximately 25-30% of all calls.

- Response Accuracy and Consistency: Agents responding to the after-implementation survey indicated by overwhelming

margins that AIDS responses were at least as accurate and had a greater level of detail than responses retrieved manually. Supervisory personnel stated that the problem of misinformation, while affecting only a small percentage (1-2%) of all calls answered, was greatest with inexperienced operators using manual materials only. Supervisors indicated that they felt much more comfortable about response accuracy when these operators consulted AIDS.

A feature of AIDS that helps ensure the near 100% accuracy of its data base is the built-in error-reporting function. If an operator receives a response that he/she deems questionable, activating the reporting function will cause the response to be listed, along with the agent's ID number, on a daily "trouble report". A review of this report by agents and management helps to locate inconsistencies or errors in the data base, as well as to identify areas in which an agent's training might be deficient. It cannot be overemphasized that this enhancement process is an interactive one in which agents and Information Section management are active participants. This interaction not only results in greater accuracy of the data base and a more workable system, but also leads to increased confidence on the part of the agents that they are personally responsible for system accuracy.

- Agent Training: Interviews with Information Section management indicated that the anticipated benefit of training time reductions for new operators does not appear to be achievable, based on results with four new agents. These agents received a two-week course which included computer practice, communications skills development, and some rudimentary background in use of manual references (they already possessed typing skills). They were not given the intensive geographic and transit system practice which forms a major part of the traditional

6-week manual training period. After two weeks, these agents were producing "acceptable" journeyman-level call counts of 80-90 per day, and it seemed as though the training reduction benefit had been achieved.

Reports from supervisory personnel, however, soon produced evidence to the contrary. Without the more extensive geographic and transit system practice, these new agents were unable to provide details to callers concerning landmarks to use as reference points during their journeys. Even worse, they were unable to make interpretive judgements between the four alternative itinerary responses routinely produced by AIDS. In the opinion of the supervisors, they became too dependent on the computer as a "crutch" for some questions such as fare and schedule requests, which other agents would have handled more quickly either manually or from memory. To remedy these observed deficiencies in their performance, these agents were later given additional training emphasizing map work and manual schedule practice. With this additional training, they were better able to picture routes, intersections, and landmarks, and achieved full proficiency (150-170 calls per day).

The net result of this experience was to point out that agents with AIDS training, but lacking a firm foundation in manual practice and geographic data manipulation, are of marginal value given the present system configuration. While these operators could be used as a stopgap measure during periods of critical manpower shortage, their long-term usefulness is limited.

- Updating of Data Base: It is important to recognize that the geographic and transit data bases, once established, are not static. Rather, they must be constantly changed to reflect changes in local land use and in transit service.

Making these changes requires a full-time effort of one WMATA employee. Data base updates are made so frequently that the AIDS geographic data base is becoming recognized as the most accurate address directory available for the D.C. metropolitan area. Anticipated cost savings due to centralized data base updating, however, have not been achieved due to the fact that hard-copy reference data are still being made available to all agents as a backup to AIDS.

- Agent Job Satisfaction: All data collected about AIDS' influence on job satisfaction point to the fact that AIDS was well-received by agents. In the before-implementation survey, 73% of agents responding chose "excellent" or "good" to describe their job satisfaction; this percentage rose following implementation to 85%. On the after-implementation questionnaire, agents were asked to rate AIDS' influence on their job satisfaction. To this question, 76% replied "positive influence" and the remainder replied "no influence". None of the responding agents responded "negative influence".
- Data Collection: The AIDS software as implemented contains a number of features which enhance system usefulness as a data collection tool. These features are currently being routinely used by supervisory and management personnel to monitor individual agent as well as system performance. Since implementation, there has been a dramatic increase in both the quantity and quality of these performance data.
- Interdepartmental/Spinoff Use: AIDS implementation has raised potentials for interdepartmental cooperation within WMATA on a scale not heretofore realized. Examples of cooperative efforts that have already been realized are as follows:

-- The WMATA Scheduling Department has benefited from standardization and storage of its data on word processing equipment. While this standardization and storage effort was a necessary expenditure for the establishment of the AIDS transit data base, it now costs the Scheduling Department less to update schedules. Since this Scheduling process is ongoing, these savings will continue indefinitely.

-- The AIDS transit data base was used as a resource by the WMATA Planning Department in the recent implementation of the automated RUCUS driver scheduling and run-cutting system. One marketing official estimated that having this transit data fully organized saved WMATA over $50,000 in implementation costs for RUCUS.

-- The WMATA Planning Department has also made use of the AIDS Daily Log File as a planning resource. For example, origins and destinations of all itinerary calls can be superimposed against a system route map to determine whether service is adequate in areas with high information demand. Frequency of demand for information on certain bus routes can also be compared with frequency of service on these routes.

Examples of potential benefits yet to be realized are as follows:

-- The WMATA Bus Stop Department can make use of AIDS in its ongoing program of providing information at MetroBus Stops. AIDS data can be used to provide printed information as to which bus routes pass by a given stop, for display at the stop.

-- The WMATA Accounting and Finance Department can use the AIDS transit data base as a resource in calculating the number of passenger route-miles provided by WMATA to each of the various local jurisdictions

in the service area. Using the data base in this fashion would greatly simplify these calculations, which form one basis for WMATA's operating subsidy assessments. Given alternative assumptions about route and service level changes, these data can also be used as a financial forecasting tool, to show the cost effects of proposal service changes.

-- Additionally, AIDS implementation has also raised the potential for other non-WMATA agencies to make use of the system. Examples of such "spinoff" possibilities are the following: First, use of the geographic data base by the Federal Government or other jurisdictions as a resource in ridesharing-car pool programs. Second, provision of the geographic base as a planning resource to local governments. (It is generally recognized that this data base is the most accurate street address directory of the D.C. metropolitan area in existence. The D.C. Council of Governments has already expressed a willingness to pay for use of this geographical data base.) Finally, provision of remote AIDS terminals at such local transportation centers for use by the general public. (Such centers might include the larger METRO stations, National and Dulles Airports, local universities, etc.)

Thus, the implementation of AIDS and the concomitant establishment of its various data bases have created a significant resource which has strong potential for serving a number of users besides information operators and callers. The overall financial justification of the system is therefore far greater than merely productivity increases and cost savings within the WMATA Office of Marketing. According to the AIDS Program Manager, the benefits created by AIDS have already greatly outweighed its overall cost to the Authority. These benefits include not only the substantial

monetary gain to WMATA due to a 10-15% increase in operator productivity. They also include less tangible factors such as increased accuracy and consistency of information provided, enhanced operator job satisfaction, and use of the unified transit data base supporting AIDS as a resource by other WMATA departments and local government agencies.

In conclusion, it is evident that the system implementation has enabled the WMATA Office of Marketing to achieve (at least partially) all of the benefits described above. With the full cooperation of management and users, future system enhancements should increase the overall success of AIDS.

1.0 INTRODUCTION

This report presents a description of the data collection and analysis efforts undertaken in the evaluation of the Automated Information Directory System (AIDS), an automated transit information system (ATIS) recently developed and implemented by the Office of Marketing at the Washington, D.C., Metropolitan Area Transit Authority. The WMATA ATIS deployment is the most ambitious and comprehensive example to date of a family of automated information systems whose principal objective is to reduce costs, increase productivity and improve service to the transit-riding public. These systems have been funded from research and development through implementation over the past eight years by the Urban Mass Transportation Administration's Office of Methods and Support. The objectives of this report are to quantify and assess the impacts of this application of ATIS technology on system users and management within WMATA, as well as on the general public in the Washington, D.C., area being served by the new system. It is hoped that the descriptions of system implementation efforts in this report will also serve to provide helpful insights for other transit properties interested in the potential application of ATIS technology to their own public information/marketing functions.

2.0 AUTOMATION OF TRANSIT INFORMATION SERVICES

2.1 THE ROLE OF TELEPHONE INFORMATION IN TRANSIT MARKETING

Transit properties have at their disposal a variety of media for marketing their services to the general public. Among these are printed schedules and maps, radio, television and newspaper advertising, and telephone information disseminated from a central office. As compared with other media, a

telephone information service has several distinct advantages. First, it is readily accessible to a substantial portion of the transit-riding public. Second, it can be easily updated to reflect changes in service. Third, and most important, it can be personalized to suit the needs of the individual customer. For those customers who do not possess printed transit schedules or maps, calling the transit telephone information service is a convenient method of learning how to make a particular trip via transit. Even those customers who possess printed transit schedules or maps often find it useful to call such a service in order to interpret or verify information. For these reasons, particularly in urban transit properties having complex systems in terms of size, number of routes, or alternative modes, a telephone information service is generally employed to overcome a major barrier to transit use: public apprehension of "getting lost" on transit.

2.2 TRADITIONAL TRANSIT INFORMATION CENTER CHARACTERISTICS

In a typical transit system telephone information center, system employees (who will be referred to as "agents") answer inquiries from prospective transit riders about schedules, routes, particular trip itineraries, fares, etc. Traditionally, the agent receives the caller's inquiry, and, if necessary, assists the caller in stating it as exactly as possible. Once the inquiry is understood, the agent consults route maps, schedules, headway sheets, or other indexed printed information located at the agent's work station, piecing together the information desired. Once an appropriate response has been retrieved, it is provided to the caller.

Under this traditional manual system of data retrieval, the agent's command of interpersonal communications skills is particularly important. Of equal importance under this system is the agent's personal knowledge of both transit system and local geographical characteristics. In order to be able to

locate quickly a desired trip's origin and destination and to select effectively appropriate transit routings between them, the agent must undergo intensive training as well as on-the-job skill development before full competency is achieved. Training and skill development is especially necessary in properties where the transit system is complex and/or its service area is large.

2.3 THE POTENTIAL FOR AUTOMATION OF AGENT DATA RETRIEVAL FUNCTIONS

Advances in computer technology over the past decade have raised the potential for automating data retrieval functions performed by transit information agents. Certain aspects of these functions lend themselves well to computer applications. First, they are highly repetitive; a very large percentage of caller inquiries can be broken down into only four or five distinct call types, each requiring consultation of certain specific data types. Thus, programming the computer for data retrieval is a relatively manageable task of duplicating agent behavior elicited by a relatively limited number of distinct call types. Second, these data retrieval functions require a high degree of agent familiarity with service area geography and transit system characteristics. These characteristics can be digitized on a coordinate grid system and mapped into the memory of a computer. Third, agent functions often involve optimization of response data to conform to limitations placed on certain trip parameters by the caller. For example, the caller might want to minimize total travel time, the number of transfers required, walking distances from stop to destination, etc. The logic underlying agent response selection in view of these caller stated limitations can be translated into comparison/optimizing computer routines in a very straightforward manner. Fourth, it is very important that agent data retrieval exhibit a high degree of consistency. While human error or

varying agent preferences or work habits may introduce a certain amount of variability in agent responses, machine logic ensures that the same inquiry will elicit the same computer response every time. Finally, due to high public demand for their services, agents must work as quickly and efficiently as possible in retrieving data. The highspeed calculating capabilities of a computer are thus particularly appropriate in this application. Except for a relatively small percentage of cases in which agents are able to answer inquiries "off the top of their heads" or very rapidly look up data, automated retrieval is faster than manual consultation of reference materials. For detailed inquiries involving multiple-transfer trips, it is substantially (minutes) faster.

Thus, automation of data retrieval functions appears to be a technically feasible means of improving a telephone information agent's capabilities in terms of response accuracy, consistency, and speed. The agent's job, however, is different under an automated transit information system. ATIS operation involves an agent's receiving telephone queries from a caller and retrieving desired information through use of a remote interactive computer terminal located at the agent's work position. The system is activated when query data are entered on the terminal keyboard by the agent. These data are then processed in the computer through pre-programmed routines selected by the agent which reference the geographical and transit data bases (addresses, fares, routes, schedules, etc.) and optimize (e.g. minimize) certain caller-stated trip parameters (travel time, transfers, fare, walking distances, etc.) through comparison of potentially feasible routing alternatives. Following processing, which is accomplished in a matter of seconds, the most appropriate responses considering given caller-stated limitations are displayed on a cathode ray tube (CRT) located above the agent's keyboard. This display is then evaluated by the agent and the appropriate information supplied to the caller.

2.4 POTENTIAL ATIS IMPLEMENTATION BENEFITS

In light of the above discussion, it appears that a well-designed and implemented automation of a transit information center would produce benefits to both the transit property and the general public. These benefits include the following:

1. Improved information agent service and productivity resulting from faster data retrieval by the computer.
2. Increased reliability and consistency of agent responses, since the computer should always supply the same answer to the same question.
3. Enhanced agent satisfaction and improved attitudes deriving from the elimination of some of the more tedious aspects of their jobs.
4. A reduction in training time for information agents, since extensive training in area geography and transit system characteristics is no longer necessary - this information would be stored in the computer's, rather than the agent's, memory.
5. Improved capability to rapidly incorporate schedule or other service changes into the information center's reference data base, since such changes would require only a simple modification of the computer's memory accessible to all agents, rather than a reprinting or modification of hard copy reference data for each.
6. Expanded capability to gather statistics about telephone information center operations since the computer can be programmed to store and compile records on all agent-directed functions and processing translations.
7. The geographical and transit system data bases used as an integral part of the ATIS could prove a valuable source of information for local government agencies or other transit system departments such as those dealing with route planning, stop locations, and service schedules.

3.0 ATIS IMPLEMENTATION AT WMATA

3.1 WMATA INFORMATION SERVICE CHARACTERISTICS

The telephone information facility in WMATA's Office of Marketing possesses a number of characteristics that made it a prime candidate for application of ATIS technology. WMATA's transit system is multi-modal, complex, and growing; its service area covers 1500 square miles and 16 separate political jurisdictions, extending out from the District of Columbia into Virginia and Maryland suburbs. Within this area, WMATA operates buses on over 800 routes in 200 separate transit corridors, as well as a rapid rail system that is projected to include 87 stations and 100 miles of rail when completed in the late 1980's. As of 1982, 39.12 miles of this rail system were in revenue service and an additional 33.52 miles were under construction.[1]

On an average day the WMATA telephone information facility receives between five and ten thousand calls on fifty different trunk lines. To meet this demand, WMATA employs a total of 57 agents and 7 supervisory personnel who answer calls in 3 shifts, 18 hours a day, 365 days a year. Despite this considerable investment in manpower, between 30 and 40 percent of all incoming calls are "lost" during peak demand periods; that figure represents those callers placed on hold by the telephone equipment because all agents are busy, and who subsequently hang up before reaching an agent or receiving any information.

---

1. Jeremy F. Plant, The Metrorail System: Its Impact On Virginia (Charlottesville, VA: University of Virginia Institute of Government Newsletter, September 1982), P.2.

3.2 AIDS PROJECT ORIGIN AND BACKGROUND (1972-1974)

The origins of the AIDS project can be traced to the early 1970's when research carried out in several locations pointed to potential cost-effective applications of computer technology to data retrieval functions. Research undertaken at the National Bureau of Standards (NBS) and at the MITRE Corporation in the Washington area investigated the costs and benefits of automated data retrieval, and work on route-finding algorithms conducted at the System Development Corporation (SDC) in Santa Monica, California, culminated in the development of the Passenger Routing System (PARIS), a proprietary system which was successfully demonstrated by SDC at the Santa Monica transit system in 1974. While the Santa Monica transit system was not very complex, this demonstration proved the system's capabilities for providing responses within a competitive time-frame; that is, at speeds equal to or better than manual agent retrieval speeds. The problem of providing accurate or reliable telephone information to potential transit customers was one which had plagued the private bus companies who were the predecessors of WMATA. When WMATA was created by interstate compact in 1973, these services were merged and placed under central management. Determined to improve this service, and having been convinced by the earlier MITRE and NBS studies that computerization held considerable promise, the Director of the newly-created Office of Marketing at WMATA was able to obtain a Federal matching capital grant for 2/3 of the $675,000 estimated as necessary to fund installation of a computer information system. The non-Federal portion of this grant was included as a line item in WMATA's first capital budget.

3.3 FEASIBILITY STUDY (1974-1975)

With this grant secured, WMATA proceeded with a feasibility study for a computer information system. In a competitive process, the feasibility study contract was awarded to Systems

Consultants, Inc. (SCI), of Washington. This contract included investigation of input data requirements, system features, possible hardware configurations, and system layout requirements.

As the study progressed, various technical and managerial problems were encountered which eventually resulted in WMATA's having work stopped under the contract. Thus, in 1975, having spent a considerable amount of the $675,000, the Office of Marketing was left with several disorganized feasibility study products, including a number of preliminary system design tasks outside the scope of the original study.

3.4 SYSTEM SPECIFICATION (1976-1977)

It was at this point that WMATA officials recognized the potential for Federal assistance in designing and implementing the AIDS project through the Technology Development and Demonstration Program. Aware that what remained of the original $675,000 capital grant would only fund the hardware and "capital" costs of the demonstration, UMTA officials approved an additional 100% Federal R&D grant in the amount of $435,000 to complete the preliminary work. This grant was used by WMATA to assimilate the SCI study products, research other necessary requirements, synthesize them into a comprehensive specification for the computerized transit information retrieval system, and develop the software needed to operate the system. Since such a system had never been implemented on such a large data base as would be required by WMATA, these were felt to be legitimate research costs for such a system.

The remaining analysis tasks and the system specification were accomplished in a cooperative effort between the Offices of Marketing and Data Processing at WMATA and the METREK Division of the MITRE Corporation in McLean, Virginia, where some of the initial work investigating data retrieval systems had been accomplished. This effort took over a year, and the

Review and Specifications for AIDS was published in July 1977.*

It was during the course of this study that many major decisions were made that had a profound effect upon ultimate system design. One such decision was to incorporate the entire WMATA service area in the system all at once, rather than beginning with a small demonstration and phasing in additional sectors as implementation progressed. This decision was based on the confidence of WMATA in system integrity and on the availability of funds to do the whole job. Another such decision was the incorporation of dedicated computer hardware rather than relying on WMATA's Data Processing Office. This decision, coupled with budget considerations, dictated that a mini-computer configuration be employed, rather than a large mainframe computer. As a result, a number of limitations on data base size and system software were introduced. The primary reason behind this choice of system configuration was the desire for independence and control over computing functions on the part of the Marketing Office. In a rapid time responsive environment, Office of Marketing officials felt that they could not afford to be held up by decisions on the part of the separate Office of Data Processing regarding scheduling of AIDS processing vis-a-vis other time-consuming (and response-slowing) data processing jobs, such as payroll computation and generation.

3.5 CONTRACTOR SELECTION (1977)

Based upon the Review and Specifications, the Office of Marketing at WMATA issued a Formal Request for Proposals for system design in late 1977. Although the RFP generated considerable interest (about 280 were sent out worldwide), only

---

* M.P. Munkasey, M.L. Noonchester, and D.F. O'Sullivan, An Automated Information Directory System (AIDS) - Review and Specifications PB 272 253 UMTA Report No. VA-06-0038-77-1, July 1977.

five proposals were received. One of these five responses was judged to be a superficial effort, and was eliminated from consideration quite early in the review process.

The remaining four system design proposals were judged separately, first with regard to technical merit and then with regard to cost. As negotiations with each of the four bidders progressed, both the bidders and the Contract Evaluation Board which was assembled to review the bids, modified their original assumptions and expectations in a process of mutual education. Major technical evaluation criteria included:

1. Understanding of large data base systems
2. Experience with geographic data bases
3. Various skills represented on the contractor management team
4. Experience with route-finding algorithms

In order that each of the four bidders be given the opportunity to better define its proposal in light of information obtained in the negotiation process, WMATA issued a "Request for Best and Final Offer" for which responses were due December 1, 1977. Based upon the responses to this request, the Contract Evaluation Board chose Kappa Systems, Inc. as system design contractor. This choice was based on several factors:

- overall understanding of the technical problems involved in system design,
- experience with satellite tracking systems which used an algorithm similar to that for AIDS, and
- willingness to work with WMATA management and users in refining the final product.

3.6 SYSTEM IMPLEMENTATION (1978-1981)

Kappa and WMATA officially began the AIDS implementation process in March 1978. Initial system implementation work was focused on three separate tasks which proceeded concurrently:

- WMATA began a series of major design changes to the

layout of its Office of Marketing in the WMATA Operations Control Building in order to accommodate the computer system. These changes included installation of new operator work stations, supervisory offices, a training room, and a computer room. They also included installation of heavy heating, ventilating, and air conditioning (HVAC) equipment for precise climate control in the computer room as well as ventilation of the operator work areas. Since the telephone information center operates long past normal working hours, it was considered desirable to control its ventilation independently of the HVAC equipment needed to service the rest of the building. These improvements cost the Authority approximately $250,000.

- Kappa began the task of generating the geographic data base, which included all the street addresses in the WMATA service area as well as over 1000 landmarks. All these addresses and landmarks were digitized on a coordinate grid. In order to obtain resolution down to the individual street address, it was necessary to construct an extremely detailed grid, with individual elements approximately 25 feet on a side. Thus, in a single square mile, there were 44,000 geographic elements; in the entire service area there were well over 50,000,000 such elements! While digitized census data was used in some cases, it proved to be unreliable for the entire service area; many sections of the geographic data base required slow, painstaking, labor-intensive hand-digitizing with little opportunity for double-checking; even the telephone directory proved to be of little value. In the digitizing effort, several recurring problems slowed progress. For example, it was necessary to arbitrarily define, in many instances, the point at which the "north" and

"south" ends of a particular street commenced. Rotary traffic intersections, which occur quite frequently in Washington, posed particular problems of intersection definition.

- WMATA began the task of assembling transit data base information, which was to be provided to Kappa in machine-readable form. From the outset, it became apparent that this task was difficult; the information was generated and updated by several different WMATA departments each with its own system for information storage and formatting.

Faced with the problem of how to standardize the poorly formatted Scheduling Department data, which were produced on antiquated machines and stored as hard copy (often modified with tape and white-out), the Office of Marketing successfully convinced WMATA's General Manager that significant cost savings in updating could be realized if the schedule data were totally reformatted on new word processing equipment and stored on floppy disks. In order to effect this change, the Office of Marketing had to purchase the word processing equipment and train Scheduling Department personnel in its use. The revised schedule data were organized in a standardized format, using time reference points that were logical from an operational point of view.

A similar problem was confronted in obtaining usable bus stop location information. Many transit authorities of comparable size have entire departments dedicated to the compilation of bus stop data; WMATA at this point had only one employee dedicated to this effort, and information storage was again on hard copy. Both Office of Marketing and Kappa personnel were assigned to assist this person in putting together a computer directory of all bus stops. A number of problems hindered this effort. First, the assignment of addresses to bus stops was rather arbitrary, but these addresses had to be clearly defined

due to the fine grid of the data base. Second, a number of separate bus lines utilized the same stops. Stops had to be clearly assigned to each bus route they served for data base purposes. This problem had not presented itself under the previous manual system of bus stop management. Solving this assignment problem was quite a labor-intensive task. Third, the sheer number of WMATA bus stops (over 11,000) made the data validation process even more cumbersome. Finally, the fact that stop locations were changing throughout the process added to the complexity of the problem.

In light of the above discussion it is evident that both WMATA and Kappa underestimated the complexity of the initial three system start-up tasks (construction/HVAC, geographic and transit data base definition). Delays were encountered in all three areas which slowed the implementation process considerably. A further exacerbating factor was the unexpected departure to another firm of the Kappa Project Manager and several key Kappa staff employees. An interim manager was named, but little else was accomplished. Because WMATA was still experiencing construction delays and transit data base difficulties during this period, however, Kappa had some excuse for non-performance. Eventually, shortly after construction of the facility was finished, WMATA marketing officials began to pressure Kappa to fulfill their contractual obligations. At this point a third Kappa project manager was named, and under his direction the long process of system data entry was accomplished in late 1980. The total cost to the Authority for the data base was approximately $275,000.

3.7 SYSTEM ACCEPTANCE AND AGENT TRAINING

Although Information Center supervisory personnel had taken an extremely active role throughout the implementation process (the Senior Supervisor even sat on the original Contract Evaluation Board), the agents themselves were only marginally

involved until the data validation and system checkout process began in 1980. Agent curiosity concerning the system, however, was quite high. When Kappa set up a demonstration terminal for agents to experiment with, all but four of the 75 center employees tried it out at one time or another.

Agents played a crucial role in the system acceptance process, however. In essence, they "fine-tuned" the system with their extensive knowledge of WMATA service characteristics. Kappa personnel produced long lists of computer responses to certain routing questions and alternative response screen formats for agents to mark up, stating preferences or reasons for observed "errors". It was through this feedback process that Kappa determined the system of weight assignments which dictated why one routing alternative might be assigned higher priority than another and the final response screen format for each of the four basic system functions (itinerary, schedule, route, fare). The attitude on the part of Kappa of "we need your help" was well received by the operators, who prided themselves on this extensive knowledge. System design personnel and WMATA management alike felt that a process of open dialogue was crucial to the usefulness of the system, as agent judgment in making choices between alternatives was the ultimate source of information in making these refinements. During this process, agents were enthusiastic participants, actively volunteering their time to ensure the best end product possible.

It was during this period that the first agent training sessions were held. Before implementation of the ATIS, the standard agent training course at WMATA lasted approximately six weeks, during which the trainees received intensive drilling on geographical, route and service characteristics, reference materials and their usage, and interpersonal communications skills. To achieve full proficiency on the system required an additional "apprenticeship" period of approximately six months of full-time work.

Although training agents to use AIDS had originally been Kappa's responsibility under the terms of the system development contract, WMATA management had been sensitized by some difficulties during initial contractor agent training for the other UMTA-sponsored ATIS demonstration at the Southern California Rapid Transit District (SCRTD) in Los Angeles. At the SCRTD the contractor training efforts appeared to have led, for various reasons, to operator mistrust of the system. Not desirous of repeating this pattern of events, WMATA officials assumed responsibility for agent training. They took a training manual for agents which had been produced by Kappa and reworked it to focus on aspects of the system which were particularly useful from the agent's perspective. The first two training classes, consisting of four agents each, were carefully selected by management for their overall maturity and experience, their receptiveness to changes in routine, and for their capabilities, once trained, to set an enthusiastic example for the other agents. Agent training consisted of typing practice (development of typing ability was considered important since many agents lacked this skill) and practice manipulating the various functions (itinerary, schedule, route and fare) as well as instruction in how to quickly scan alternative responses (the system usually produces four alternative responses to an operator query) to select the "best" response in light of the caller's request. Agents in the early training sessions were instructed to keep any negative comments about the system to themselves, at least for the short run. It was generally conceded by Kappa that the geographic and transit data bases contained numerous errors; agents were openly told that these errors might occur, and that part of their job was to assist Kappa in finding and correcting them. This process was greatly facilitated by a built-in error reporting function in the system software. If an agent received a response which he or she deemed questionable, it could easily be stored for future reference and correction. Sessions in

which these questionable responses were discussed by agents and Kappa representatives proved to be particularly fruitful and instructive to both parties. In many instances, the minimum-travel time routing selected by the computer was not the "intuitive" or "obvious" choice selected by the agent. For example, the computer might instruct a caller to walk several blocks and catch an express bus rather than catch a local bus for which no walking was required. Agents in many such instances had to reluctantly concede that the computer's selection was indeed better from the standpoint of travel time. In some instances, however, agent judgment was better. For example, a certain computer routing might at first glance seem to be the best choice, but it might contain a segment which the agent considered inadvisable or impossible. Typical agent comments to these routings were "I wouldn't transfer in that neighborhood at that time of night.", or "How can you cross that highway to reach the transfer stop?", etc. In these instances, the agent's detailed knowledge of local pedestrian traffic routings outweighed the pre-programmed computer response. While there were initially a considerable number of error reports, these gradually tapered off as corrections were made and system acceptance was fully complete in February 1981.

It should be emphasized that agent training at this stage of AIDS development was limited to experienced agents who had already received the intensive six-week training course for new agents. As of the writing of this report, WMATA experience in training new agents directly on AIDS was extremely limited.

4.0 SYSTEM EVALUATION

With the full cooperation of the management and staff of WMATA's Office of Marketing, Wilson Hill Associates in the Spring of 1980 designed a comprehensive program for collection and evaluation of data concerning AIDS. These data were collected

in April-May, 1980, November, 1980, and October-November-December, 1981. The major goals of this program were to determine, as accurately as possible, answers to the following questions:

- In what ways does AIDS affect the Telephone Information Section's productivity, i.e., the overall quantity of agent responses provided?
- In what ways does AIDS affect the quality, (i.e., the accuracy and consistency) of agent responses provided?
- How does AIDS affect an average agent's performance of normal job functions? How does it change the agent's perception of his/her job?
- What impacts does AIDS have on the training process for new agents?
- What other impacts, positive or negative, does the system exert on other WMATA departments and on the general public?

A number of different data collection instruments were implemented as elements of this evaluation program, taking advantage of a variety of different information sources. Sources employed in obtaining both quantitative and qualitative data are described below.

4.1 QUANTITATIVE DATA SOURCES

In evaluating the impacts of AIDS on a quantitative basis, there were two primary objectives. The first was to measure the characteristics of caller demands placed on the information center. The second was to gain a better understanding of those aspects of operator performance which could be quantified. Several different sources were employed in this effort:

- Automatic Call Distribution System readings
- Call monitoring
- Computer Data

The Automatic Call Distribution (ACD) system, manufactured by Stromberg-Carlson, routes incoming calls to the information agents. When a call is received, it is either routed to an available agent or, if all agents are busy, it is routed to a holding queue. Once a call is placed on this queue, it receives a recorded message stating that all operators are busy and instructing callers in preparing their inquiries. Calls are routed from the queue on a first-in, first-out basis; that is, the caller waiting "on hold" for the longest time is answered first.

The ACD system proved to be a valuable source of data concerning both caller demand and agent performance. Using a device called a "peg counter", it mechanically records the number of calls entering the system and the number of calls which are "lost", i.e., those which are ended by the caller before reaching an agent. On a standard form, incoming calls and lost calls are recorded from the counter each hour by WMATA supervisory personnel. Once these data are recorded, the ACD counter is reset to zero for the next hour's count. ACD data is used extensively by WMATA as an indication of agent and center performance as well as caller demand levels.

Call monitoring is another technique used routinely by WMATA supervisory personnel to check on agent performance. All agent work positions are fitted with jacks so that additional headsets can be plugged in for monitoring. Call monitoring proved useful in obtaining more detailed information concerning individual operator performance than was available from the ACD system counts. For example, call content, agent data retrieval time, data sources referenced, and the total call time were recorded in this manner. Of course, since monitoring was limited in focus to an individual agent, it was necessary to monitor a large number of calls handled by many different agents in order to gain statistical confidence regarding monitoring results.

The AIDS system, once operational, proved to be a valuable source of agent performance data as well. System specifications for AIDS required a "report generator" program be included in the system capable of "printing information handled through the central computer".* A series of summary reports of daily computer activity are printed. Typical data included in these reports are:

By Hour of the Day:

- Maximum number of active AIDS terminals
- Number of itinerary, schedule, route and fare queries completed
- Number of "errors"
- Number of "keyed functions"

By Individual Agent:

- Agent name and ID number
- Number of minutes logged-in
- Number of itinerary, schedule, route and fare "replies received"
- Number of "errors"

In these reports "errors" include any inputs which are not recognizable elements of the computer's data base. They may be the result of incorrect caller information, agent misspellings, or other data entry errors. "Keyed functions" are all data inputs, including errors. "Replies received" are useful data outputs which do not include system error messages.

---

* Munkasey, Noonchester and O'Sullivan, op. cit., p. 9.

4.2 QUALITATIVE DATA SOURCES

The major objectives of the qualitative data collection effort were to gain useful information regarding those aspects of AIDS operation that were difficult or impossible to quantify. Such information included agent attitudes towards AIDS and their opinions regarding its accuracy, its impact on their job functions, its effects on callers, its influence on their job satisfaction, etc. It also included WMATA management perceptions as to how system implementation was progressing, how effectively it was being used by the agents, etc. Two techniques were used to gather these data:

- Survey questionnaires of operators
- Direct interviews of WMATA personnel involved in system implementation as well as information agents.

Questions asked in the agent opinion/attitude questionnaires were generally multiple-choice in format although several questions also provided blanks for agents to supply additional written responses if they desired to do so. Overall length of the questionnaires was limited to approximately 15 questions to ensure maximum participation on the part of the agents. Responses were coded numerically and processed to yield frequencies of each possible response, as well as cross-tabulation of responses.

Interviews of management personnel and operators attempted to focus on their perceptions of AIDS' impacts on their jobs and the jobs of their subordinates. These impact areas were often discussed by the interviewees more in terms of future or expected results than actual verified impacts. This focus was due to the relative newness of the system and the fact that agents were still adjusting to it. Interviews were very helpful, however, in revealing agent job styles and in determining costs and benefits of the system.

4.3 EVALUATION METHODOLOGY

The methodology employed by Wilson Hill in evaluating AIDS

was the product of two major determining factors:

- The institutional support for full AIDS implementation on the part of WMATA management; and
- The timing of system implementation.

WMATA Office of Marketing officials had few misgivings concerning the potential effectiveness of AIDS. This attitude was reflected in their decisions to incorporate full service-area coverage and dedicated hardware into the system and to train all operators in its use. It was not considered important by these officials, therefore, to experimentally validate the usefulness of computerized data retrieval against the manual mode. Rather, the major question on the part of WMATA was: "How well are the agents making use of the computer system?" Most evaluation components were designed with this question in mind.

The timing of system implementation was particularly fortuitous for evaluation purposes. When the evaluation began, Kappa was still putting AIDS through its system acceptance testing and the system was not yet operational. The operators in the Telephone Information Section were therefore still using manual data retrieval to handle all calls. This circumstance presented the opportunity for collection of data under the manual mode which could later be used as a baseline for comparison with data to be gathered when AIDS was fully operational and agents were trained and familiar with its use. This "before-and-after" approach was used for evaluation of ACD, call monitoring, and agent survey data.

4.4 BEFORE-IMPLEMENTATION ACD DATA

In the initial data collection phase, it was considered useful to examine a limited amount of Automatic Call Distribution System data to gain an overview of caller demand magnitudes and the percentage of calls answered and "lost" under manual operation. The figures shown in Table 4-1 are typical of the ACD data. They depict total calls received,

TABLE 4-1

TYPICAL "BEFORE" ACD DATA

DATE (1980)	TOTAL CALLS	CALLS ANSWERED	CALLS LOST	PERCENT ANSWERED
4/20	5823	5278	545	90.6
4/21	8069	6854	1215	84.9
4/22	7115	6669	446	93.7
4/23	7009	6503	506	92.8
4/24	6711	6479	232	96.5
4/25	6486	6321	165	97.5
4/26	5755	4780	975	83.1
4/27	5021	4478	543	89.2
4/28	8762	6678	2084	76.2
4/29	7650	7425	225	97.1
4/30	6842	6559	283	95.9
5/1	6729	6368	361	94.6
5/2	6877	6407	470	93.2
5/3	6529	5463	1066	83.7
AVERAGE	6813	6162	651	90.6
STANDARD DEVIATION	905	807	508	

calls answered, calls "lost" and percentages answered over a two week period from April 20 - May 3, 1980. During this period, daily calls received ranged from 5021 to 8762, with an average of 6813 and a standard deviation of 905. Daily calls answered ranged from 4478 to 7425, with an average of 6162 and a standard deviation of 807. The most interesting feature of these ACD statistics is their fluctuation throughout the week. Figure 4-1 plots total calls and answered calls as a total of average weekly calls received. In this figure, it can be seen that caller demand peaks at approximately 17.5% of weekly demand on Mondays, and declines steadily throughout the week to a level slightly below 13% on Saturdays and Sundays. This peaking of caller demand on Mondays is also reflected in the "percent answered" figures in the last column of Table 4-1. From these figures, it can be seen that the agent work force was insufficient to meet Monday demands (4/21 and 4/28) but quite adequate on the other weekdays. Calls answered range between 13 and 14.5% of weekly demand throughout the week and decline to slightly above 10% on weekends. This weekend variation can be explained by the smaller agent work force available to answer calls on weekends.

Thus, the ACD data gathered before system implementation indicates that the center did a very good job of handling demand on Tuesdays through Fridays, with an average of 95% of calls answered on these days. On Saturday, Sunday and Monday, center staffing was evidently inadequate to handle demand, and an average of only 85% of calls were answered on these days.

4.5 BEFORE-IMPLEMENTATION CALL MONITORING

In order to gain as much information as possible concerning agent work habits and job styles under manual operation, a call sampling effort was undertaken over a period of six weeks, from October 20 to November 26, 1980. In this effort, incoming calls were selected at random by a part-time Wilson Hill employee located at a supervisory work station in the Customer Information

FIGURE 4-1

DAILY VARIATION IN CALLS RECEIVED AND CALLS ANSWERED

BEFORE IMPLEMENTATION

Source: ACD Records

section. From this location, operators could be unobtrusively monitored and observed. For each call monitored, a separate line of data was recorded by the observer on a data sheet. Data recorded included time of day, operator monitored, total elapsed time of call, type of query, materials consulted by operator, mode of transit described in operator response, and any other qualitative descriptions or call "problems" that were considered relevant (for example, a caller comprehension problem which resulted in the operator's repeating instructions). In all, a total of 1,789 calls were successfully documented in this fashion. Raw data sheets were then coded numerically, transcribed into a computer file, and processed using a Statistical Package for the Social Sciences (SPSS) computer program. Output of this program consisted of frequencies for each variable recorded as well as a variety of two-dimensional cross-tabulations.

The large amount of data collected in this before-implementation sampling effort permits generally reliable statements to be made concerning the call characteristics recorded. Findings regarding these characteristics are described below.

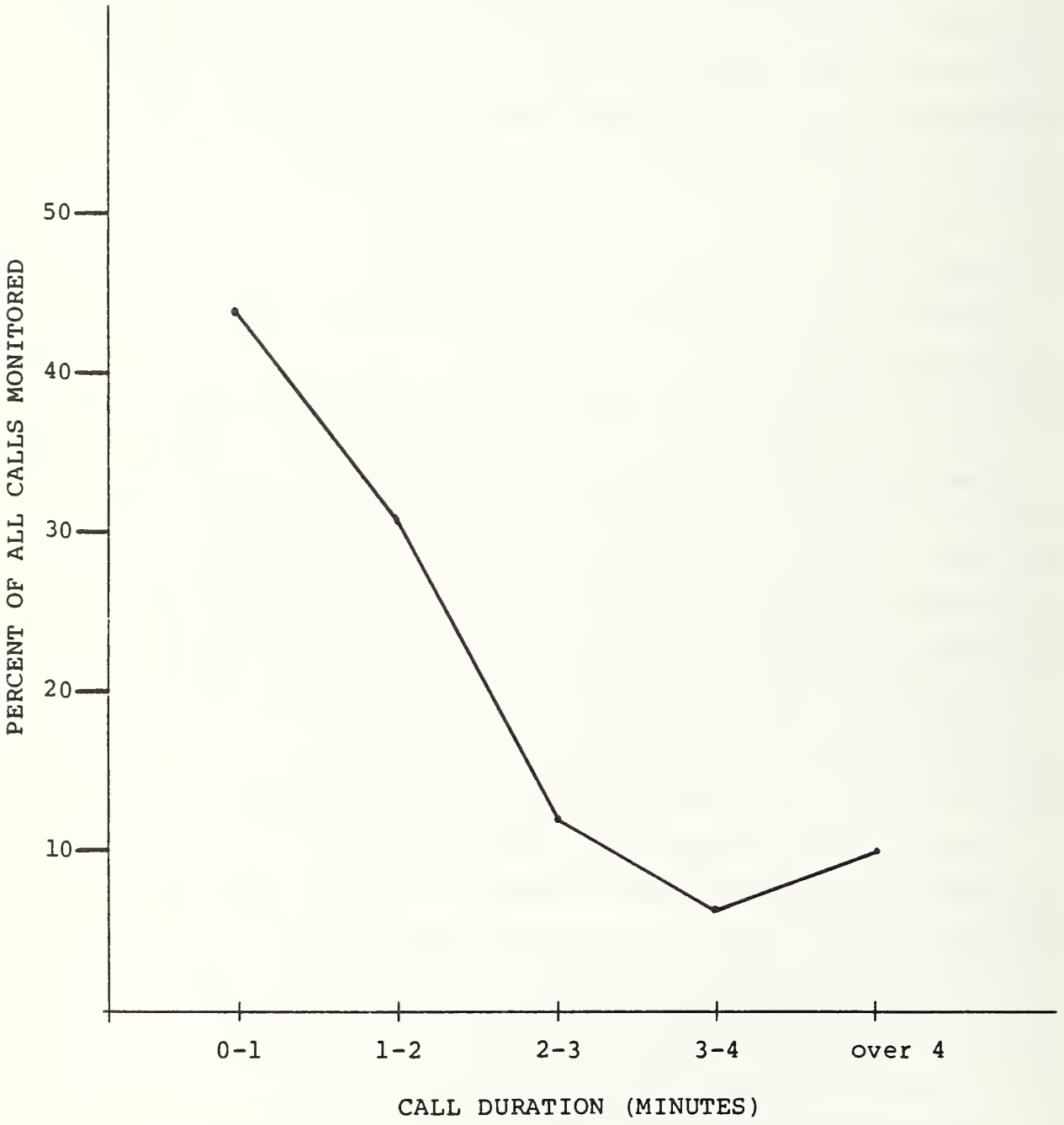
- An overwhelming majority of the calls monitored involved relatively direct and straightforward requests for information. In a total of 1,258, or 71.4% of these calls, only one or two specific caller requests were made (i.e. concerning a specific itinerary or schedule). An additional 411, or 23.3%, involved three or four requests. Only in 93 of the calls, or 5.3% of the total, were there five or more distinct caller queries. This tendency towards brief caller requests is obviously a contributing factor to high operator call productivity in the Customer Information Section.
- A total of 1,256, or 76.1% of those calls in which a transit mode was mentioned, dealt exclusively with bus transportation. 135 calls, or 8.2%, requested information about rail transit only. In 260 calls, or 15.7%, both modes were mentioned. One possible explanation for this observed distribution is the fact that only a portion of the planned WMATA rail

system was in operation, while the bus network is quite extensive and complex. Another explanation might be that marketing promotions of the rail transit system have made it much more familiar to area residents than the WMATA Metrobus system.

- Information was also recorded regarding the content of caller queries. In many cases, a certain amount of judgment on the part of the person monitoring the calls was required for this task. Customer queries were classified as itinerary, schedule, route, fare, or other requests. The "other" category included a variety of queries, the majority of which were related to senior citizen discounts or special flash-pass programs. Itinerary requests were by far the most popular, accounting for two-thirds of the total. Schedule requests were the next most frequent, comprising 24%. Fare requests made up 7% of the total while route and other requests accounted for the remaining 3%.
- Because the person monitoring the calls could observe telephone operators in action, it was possible to record the types of reference materials consulted in retrieving data for callers. Four separate categories of reference material were recorded: maps only, printed materials only, both maps and printed materials, or none (agent memory of system). The frequency with which agents can answer queries "off the top of their heads" without consulting any reference has strong implications for overall system productivity, since such responses involve no data retrieval time and are generally completed quickly. In the 1,305 instances in which reference use was recorded, agents consulted only maps on 367 calls, or 28.1% of the total; they used only printed materials on 535 calls, or 41% of the total; and both maps and schedules on 212 calls, or 16.2% of the total. They were able to answer 191, or 14.6% of all queries, "off the top of their heads".

- Total elapsed time of each call monitored was recorded using a stopwatch. The vast majority of calls were relatively brief; a total of 751, or 42.1% of the 1,782 calls whose times were recorded, lasted one minute or less. An additional 565, or 31.7% of the total, lasted between one and two minutes. There were 234 calls with elapsed times between two and three minutes, 13.7% of the total. Ninety-seven calls, or 5.4% of the total, lasted between three and four minutes. Only 135 calls, or 7.6% of the total, took longer than four minutes to complete. This call distribution reflects an average of slightly more than two minutes, or an average operator productivity of approximately 25 to 30 calls per hour, assuming the operator works continuously without any breaks between calls. Figure 4-2 plots the frequency distribution described above.
- Included in the data sheet used by the person monitoring calls was a section in which notations could be made concerning any problems which caused longer than usual call times. In coding the data sheets, these notations were classified into four separate categories: calls in which the operator repeated information to the caller, calls in which the caller could not understand the operator's response, calls in which the caller was unfamiliar with locations described by the operator, and calls in which the operator was unable to find locations referred to by the caller. No problems were noted by the observer in 1,391 calls, or 77.8% of the total. Agents repeated information on 251 calls, or 14% of the total. Customer comprehension problems were noted on 25 calls, or 1.4% of the total. In 86 calls, or 4.8% of the total, the caller did not recognize locations described by the operator. In only 36 instances, or 2% of the total, was the operator unable to find locations described by the customer.

FIGURE 4-2
FREQUENCY DISTRIBUTION OF CALL TIMES
BEFORE IMPLEMENTATION CALL MONITORING



Source: WHA Call Monitoring

- All but one of the cross-tabulations produced from the coded call monitoring data incorporated a time interval (hour, day, week) as one of the variables. Because data were not collected continuously, and only a small percentage of total incoming calls were monitored, it is not possible to make broad generalizations from the distributions over time of the variables as recorded. For example, the fact that call totals for a particular hour or day of the week were higher than those for other hours or days does not necessarily imply that the customer information section was busier during these periods; it merely means that the person collecting the data was busier. Table 4-2 presents the single cross-tabulation generated in data processing which does not have a unit of time as one of the variables. In this table, the frequency of use of reference materials is tabulated against the distribution of call times. Examination of this table yields some interesting conclusions. First, those calls in which operators consulted only maps generally took longer to complete than those in which only printed materials were referenced. Approximately 25% of the "maps only" calls were completed in less than one minute, while slightly under half the "printed materials only" calls were completed in this time. Second, those calls which required an agent to consult both reference types had generally the longest durations; 38% of these calls had durations of over three minutes. Finally, as might be expected, those calls in which no reference materials are used generally took the shortest time to complete; approximately two-thirds of these calls lasted less than one minute.

TABLE 4-2

CROSS-TABULATION OF REFERENCE USE VS CALL TIME

BEFORE IMPLEMENTATION CALL MONITORING

REFERENCES CONSULTED	CALL TIME (MINUTES)					TOTAL
	0-1	1-2	2-3	3-4	OVER 4	
MAPS ONLY	95	151	69	24	28	367
PRINTED MATERIALS ONLY	262	175	55	15	26	533
MAPS AND PRINTED MATERIALS	13	66	51	29	51	210
NO REFERENCES	127	48	14	1	1	191
TOTAL	497	441	189	69	106	1302
PERCENT OF TOTAL	38.2	33.9	14.5	5.3	8.1	

Source: WHA Call Monitoring

4.6 BEFORE-IMPLEMENTATION AGENT QUESTIONNAIRE

The before-implementation agent questionnaire was designed and administered to WMATA operators during November 1980. This survey was designed to encourage maximum participation on the part of the agents. Overall length was limited to 14 questions, most of which were presented in a multiple-choice format. On five questions, however, a blank was provided for "open-ended" responses by agents who chose to volunteer additional information. Agent response to the survey was excellent; a total of 42 surveys were completed and returned for processing. Responses were coded numerically and analyzed using a Statistical Package for the Social Sciences (SPSS) computer program. This processing yielded frequencies for each possible response as presented below.

- To the question "How long have you worked as a Transit Information Agent?", three agents responsed "six months or less", eight responded "seven to twelve months"; 13 responded "one to three years"; nine responded "three to five years"; and nine responded "more than five years". Average agent experience reflected by this distribution is at least 25 months. This distribution is shown in the last column of Table 4-4.
- The number of calls handled by an agent in an hour is the standard for productivity at WMATA. When asked "How many calls do you process per hour under busy conditions?", two agents replied "15 or below"; five replied "16 to 20"; 15 replied "21 to 25"; 12 replied "25 to 30"; and eight replied over 30". This response distribution represents an average agent productivity of at least 22 calls per hour. It is shown in the bottom row of Table 4-4.

- When asked "Do you feel your skill at the job increases with time?" 24 agents responded "yes"; and 17 agents responded "does for a while and then levels off". None of the agents surveyed chose the "no" response. This result would indicate strong support for intensive agent training during the first few months of call processing to increase agent competence and familiarity with the system.
- Agents were asked to rate the physical requirements of their job on the average day. Three separate response categories were provided, along with a blank labeled "explain" for agents who cared to supply any more information on the subject. Eleven agents rated the job as "very fatiguing"; 27 termed it "somewhat fatiguing"; and only three agents chose the "little or no fatigue" response. A total of 28 agents added explanations of these responses in the blank provided. Of these, six responses might be classified under the general complaint of "tedious and repetitive"; seven mentioned having to "sit all day", and 15 noted "eye strain", "mental strain", or "headaches" caused by the job.
- A series of five questions dealt with the reference materials available to the agents under the existing manual system of data retrieval. These materials include system maps, route descriptions, and headway sheets. Also included under "reference materials" was the category "personal knowledge of the system" since agents are sometimes able to respond to caller requests without ccnsulting any printed reference material. When asked which of these materials they considered the most valuable, 18 agents replied "maps"; 10 replied "personal knowledge of the system"; five replied "route descriptions"; five replied "headway sheets"; and one replied all of the above. This distribution is shown in the bottom row of

Table 4-5.

Table 4-3 shows results obtained when agents were asked how frequently they consulted the references mentioned above. As can be seen in this table, headway sheets are the most frequently used, followed by personal knowledge, maps and route descriptions, respectively. The frequency with which agents are able to respond to caller queries from memory is an important factor in overall productivity, since this type of response requires no data retrieval time. The fact that this is the second most popular "reference" consulted is reflected in the high agent productivity figures reported above.

- Agents were given a choice of five alternative responses to the question "What, in your opinion, is the biggest problem in processing calls?", plus a blank in which additional information could be supplied. A total of 18 out of 40 agents who answered this questions chose the response "customer understanding of information"; 10 agents chose "keeping up with changes in routes, schedules and fares"; four chose "understanding customer's question"; three chose "customer impatience"; and two chose "retrieving information in reference material". Eight agents provided additional information in the blank. Of these, five emphasized that getting customer cooperation was their biggest problem, while three stated all of the factors listed were equally important.
- Agents responded generally favorably to the question "How satisfied are you with your job?" Seven agents replied "very satisfied"; and 24 replied "somewhat satisfied", while 10 replied "unsatisfied" and only one replied "very unsatisfied".
- For the question "What duties do you like most about your job?", no alternative answers were provided; just a blank for agents to supply their own comments. A total of 35

TABLE 4-3

AGENT-REPORTED FREQUENCY OF REFERENCE USE

BEFORE IMPLEMENTATION AGENT SURVEY

REFERENCE MATERIAL	FREQUENCY OF USE			
	HARDLY AT ALL	SOMETIMES	FREQUENTLY	VERY FREQUENTLY
PERSONAL KNOWLEDGE	1	8	24	9
MAPS	1	16	16	9
ROUTE DESCRIPTIONS	12	20	10	0
HEADWAY SHEETS	2	2	14	24
TOTAL	16	46	64	42
% OF ALL RESPONSES	10	27	38	25

TABLE 4-4

CROSS-TABULATION OF AGENT EXPERIENCE VS CALL COUNT

BEFORE IMPLEMENTATION AGENT SURVEY

EXPERIENCE AS AN AGENT	CALL COUNT PER HOUR					TOTAL
	15 OR LESS	16-20	21-25	26-30	OVER 30	
6 MO. OR LESS	1	2	0	0	0	3
7 - 12 MOS.	1	2	3	1	1	8
1 - 3 YRS.	0	0	6	5	2	13
3 - 5 YRS.	0	1	3	4	1	9
OVER 5 YRS.	0	0	3	2	4	9
TOTAL	2	5	15	12	8	42

agents responded. The most frequent response, mentioned by a total of 17 agents, might generally be termed "helping people". Other responses included "working with the public", "helping customers save money" and "giving good, accurate information".

- To the question "What duties do you dislike most about your job?", once again only a blank was provided for agent comment. A total of 35 agents responded with a wide variety of comments, including "management pressure for higher call counts", "repetition" or "monotony", "dealing with difficult customers", "callers who use foul language" and "poor quality of reference materials".
- The final questions on the survey dealt with agent perceptions of changes to their jobs due to the implementation of AIDS. While none of the agents had yet received training on AIDS, they were all aware that its installation was being planned; they had seen demonstrations of its use. To the question, "What effect do you think the new computerized information system (AIDS) will have on your job?", two agents chose the response "no change"; 24 agents chose "some improvement"; 10 chose "big improvement"; and five chose "be worse". This distribution is shown in Table 4-6. A blank was provided in which agents could explain their response if they so chose; a total of 31 agents provided comments. Those agents who felt AIDS would be an improvement generally mentioned retrieval speed and the accuracy and consistency of the data it would provide. Some agents stated that it would make their jobs "more professional". Those who felt it would have no effect or would make their job worse for the most part made comments such as "computers are too slow", "information will be inaccurate", or "I'll have to wait and see".

A number of two-dimensional cross-tabulations were run on

the response data collected in an attempt to identify any interesting patterns that might not have been evident in the response frequencies. Tables 4-4 through 4-7 present four such cross-tabulations.

- In Table 4-4 agent experience responses are tabulated against their responses indicating agent call count per hour. Looking at this table, it can be seen that there is a frequency of responses along the diagonal running from the upper left corner to the lower right corner. This pattern lends support to the notion that agent call counts increase with experience, a result that was obtained in the third survey question ("Do you feel your skill at the job increases with time?"), to which agent responses were strongly affirmative.
- In Table 4-5 agent call count responses are tabulated against their responses concerning reference materials considered most valuable. From this table, it can be seen that eight of those agents with call counts greater than 25 per hour stated that they considered personal knowledge of the system to be more important than any other reference type. Conversely, only two agents with call counts below 25 per hour cited personal knowledge as the most important reference. This result would lend credence to the hypothesis that increased productivity is strongly dependent on the frequency with which agents can respond to caller queries "off the top of their heads".
- Table 4-6 presents responses concerning agent experience tabulated against agent responses concerning feelings about AIDS system implementation. From this table, it can be seen that the generally favorable agent disposition towards AIDS changeover is reflected across all experience categories. Even those agents with over five years' experience using manual retrieval felt quite strongly (seven agents to two) that AIDS would cause at least some improvement in their jobs.

TABLE 4-5

CROSS-TABULATION OF CALL COUNT VS REFERENCE MATERIALS CONSIDERED MOST IMPORTANT

BEFORE IMPLEMENTATION AGENT SURVEY

CALL COUNT PER HOUR	REFERENCE MATERIALS CONSIDERED MOST IMPORTANT					TOTAL
	PERSONAL KNOWLEDGE	SYSTEM MAPS	ROUTE DESCRIPTION	HEADWAY SHEETS	OTHER	
15 Or Less	0	1	1	0	0	2
16 - 20	1	2	0	1	1	5
21 - 25	1	5	4	2	3	15
26 - 30	4	7	0	1	0	12
Over 30	4	3	0	1	0	8
TOTAL	10	18	5	5	4	42

TABLE 4-6

CROSS-TABULATION OF AGENT EXPERIENCE VS FEELINGS CONCERNING AIDS IMPLEMENTATION

BEFORE IMPLEMENTATION AGENT SURVEY

EXPERIENCE AS AN AGENT	FEELINGS CONCERNING AIDS				TOTAL
	NO CHANGE	SOME IMPROVEMENT	BIG IMPROVEMENT	BE WORSE	
0 - 6 MO.	0	3	0	0	3
7 - 12 MO.	0	6	0	1	7
1 - 3 YRS.	0	7	4	2	13
3 - 5 YRS.	1	4	3	1	9
OVER 5 YRS.	1	4	3	1	9
TOTAL	2	24	10	5	41

- Table 4-7 cross-tabulates the same responses concerning AIDS changeover shown in Table 4-6 versus explanations of these feelings provided in the open-ended "please explain" following the question. From this table, it can be seen that the four agents who think AIDS implementation will have a detrimental effect on their jobs stated that they would take a "wait and see" attitude until the system was implemented. Those agents who felt AIDS would improve their job generally cited the faster retrieval speed and improved accuracy and consistency of the AIDS data base as compared with the manual references currently available.

4.7 AFTER-IMPLEMENTATION ACD DATA

In the post-implementation data collection phase, ACD data recorded by supervisory personnel in the Telephone Information Section were once again made available to Wilson Hill. These data are indicative of section performance under steady-state operation of AIDS.

It should be noted that AIDS was implemented as a supplement to manual retrieval and that during the post-implementation data collection phase all agents still had access to and training in the use of manual data sources. Thus, even in full operation, not all calls resulted in AIDS' transactions being processed. Thus, the AIDS daily log file, while presenting a very accurate description of system transactions, did not provide a total picture of post-implementation Telephone Information Section operations. For this comprehensive picture, the ACD data were still required.

Table 4-8 presents a summary of the after-implementation ACD data, which cover the period from October 19 to November 30, 1981. This is a longer period than the pre-implementation data made available; results can therefore be viewed as slightly more reliable than those for pre-implementation. During this period total daily calls received ranged from 4116 to 9232, with an average of 5985 and a standard deviation of

TABLE 4-7

CROSS-TABULATION OF FEELINGS CONCERNING
AIDS IMPLEMENTATION VS EXPLANATION OF THESE FEELINGS

BEFORE IMPLEMENTATION AGENT SURVEY

AGENT FEELINGS REGARDING AIDS	EXPLANATION OF THESE FEELINGS				
	FASTER RE-SPONSE	IMPROVED INFOR-MATION	PRESENT SYSTEM BETTER	WAIT AND SEE	OTHER
NO CHANGE	0	0	0	0	2
SOME IMPROVEMENT	8	2	1	0	1
BIG IMPROVEMENT	6	3	0	0	0
BE WORSE	0	0	0	4	0

TABLE 4-8

AFTER-IMPLEMENTATION ACD DATA

(AVERAGES FOR 6-WEEK DATA COLLECTION PERIOD)

DAY OF WEEK	CALLS RECEIVED	CALLS ANSWERED	CALLS LOST	PERCENT ANSWERED
MONDAY	7022	5507	1515	78.4
TUESDAY	6910	5715	1195	82.7
WEDNESDAY	6799	5761	1038	84.7
THURSDAY	5801	5183	618	89.3
FRIDAY	6051	5581	470	92.2
SATURDAY	5006	4299	707	85.9
SUNDAY	4304	4105	199	95.4
OVERALL AVERAGE	5985	5164	821	86.3
OVERALL STANDARD DEVIATION	957	635	420	

Source: WMATA ACD Readings

1150. Calls answered daily ranged from 3526 to 7214, with an average of 5164 and a standard deviation of 801. Thus, both total daily customer demand and total daily calls answered are approximately 1000 less, on average, than their pre-implementation levels. Explanations for this discrepancy might include seasonal variations in demand, varying agent work forces, and variations in average agent experience.

From Table 4-8, it can be seen that the daily post-implementation patterns of caller demand and system performance are, with several minor variations, very similar to the pre-implementation patterns described above. Figure 4-3 shows these daily patterns expressed as percentages of total average weekly calls, with the similar percentages from Figure 4-1 superimposed for comparison. It can be seen from this Figure that demand again peaks on Monday at nearly 17% of total weekly demand and declines throughout the week, with a slight upward trend on Friday, to just above 10% on Sunday. From Monday through Friday, calls answered range between 13 and 14 per cent of total weekly demand, while on weekends, this percentage is reduced to between 9 and 10 per cent.

These ACD data indicate that the Information Center handled incoming demand best on Thursdays, Fridays, and Sundays, averaging just over 90% of calls on these days. On Wednesdays and Saturdays, this efficiency fell to around 85%, while the peak demands of Mondays and Tuesdays still presented a problem, with approximately 80% of calls being answered on these days.

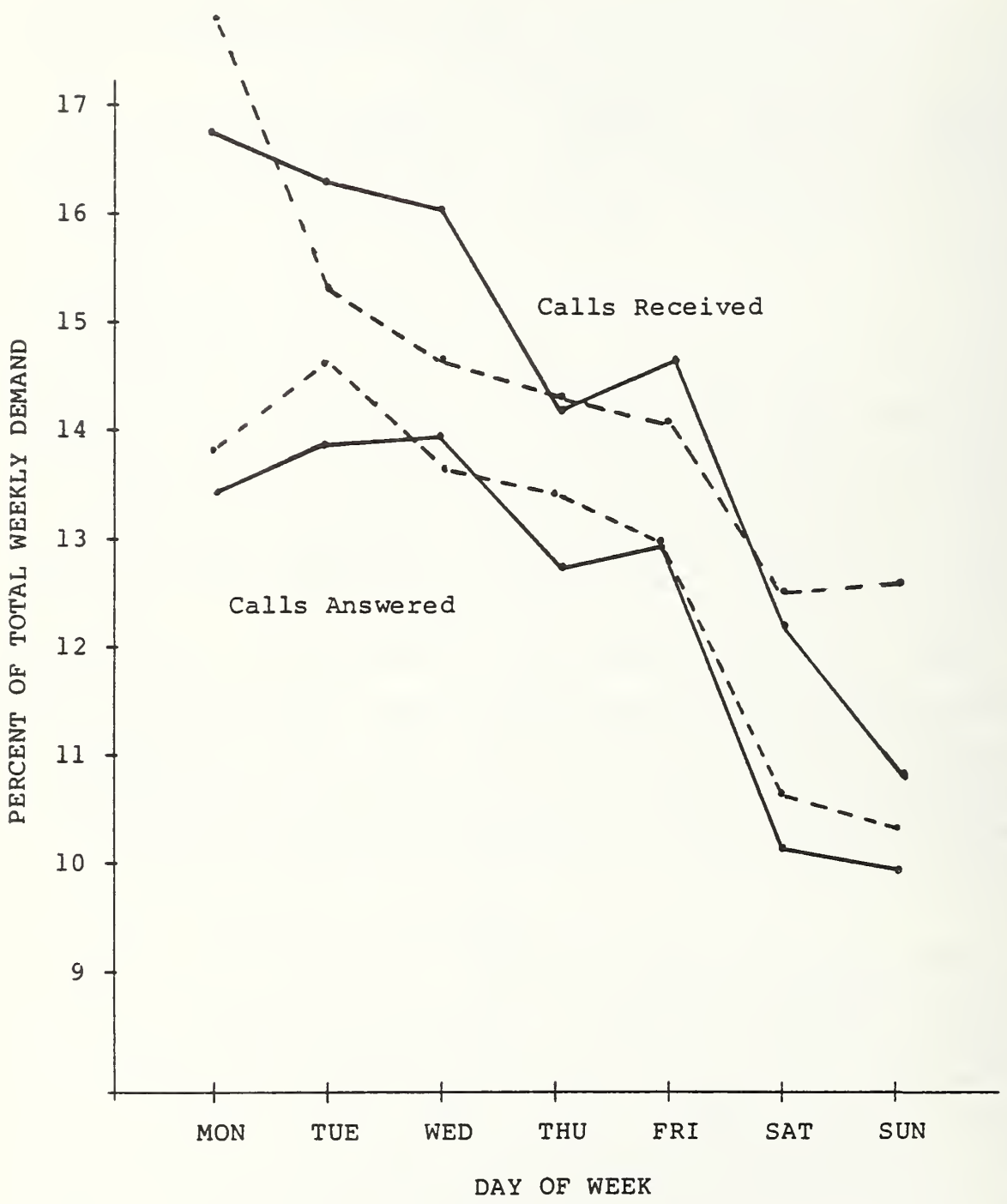
4.8 AIDS DAILY LOG FILE STATISTICS

An important component of after-implementation data was the daily log file of computer transactions automatically kept by the AIDS. These data present an accurate and comprehensive picture of agent computer usage. Taken in the context of the after-implementation ACD statistics, they provide a measure of the extent to which agents are selecting computer data retrieval

FIGURE 4-3

DAILY VARIATION IN CALLS RECEIVED AND CALLS ANSWERED

AFTER IMPLEMENTATION
(BEFORE-IMPLEMENTATION DATA SHOWN IN DOTTED LINES)



Source: WMATA ACD Readings

over manual mode methods. Daily computer log files covering the period from October 1 to November 15, 1981 were made available to Wilson Hill for evaluation. From these files, a number of interesting characteristics of AIDS were determined. These usage characteristics are described below:

- Agents chose to use computer transactions for data retrieval about eight to nine times per hour logged-on, on average, during the period for which data was cllected. Average computer use is highest during the Monday-Tuesday-Wednesday demand peaks, and declines somewhat through the remainder of the week. Table 4-9 displays average total keyed functions per hour logged-on by day of the week.
- A fair number of agent data inputs result in error messages or prompts from the AIDS computer. As discussed previously, these "errors" can be attributed to agent misspellings or input format errors, or to caller misinformation. As can be seen in Table 4-9, these errors occurred at the rate of approximately four per hour logged-on, on average. Thus, valid transactions which yielded useful data to the agent (and the caller) occurred at a rate of just under five per hour, on average. This implies that 43% of all data entries, or one keyed transaction out of every 2.31 entries, results in a system error response. While this percentage may appear to be unacceptably high, it should be emphasized that callers account for some errors. With increasing agent experience, it should be expected that this "error" rate will decrease.
- Table 4-10 displays percentages, averaged by week of the data collection period, of total valid AIDS functions for each of the four function types (itinerary, schedule, route, and fare). From this table, it is evident that the itinerary function is by far the most popular with callers and agents, accounting for almost 84% of all transactions. The schedule function is the next most

TABLE 4-9

CHARACTERISTICS OF AIDS USAGE
(AVERAGES FOR 6-WEEK PERIOD, FIGURES SHOWN
PER HOUR LOGGED-ON)

DAY OF WEEK	TOTAL KEYED FUNCTIONS	TOTAL "ERRORS" REPORTED	TOTAL VALID TRANSACTIONS	RATIO OF VALID/ TOTAL
MONDAY	9.37	3.97	5.40	57.6%
TUESDAY	9.89	3.54	6.35	64.2%
WEDNESDAY	9.70	3.81	5.89	60.7%
THURSDAY	7.82	3.27	4.55	58.2%
FRIDAY	8.43	3.40	5.03	59.7%
SATURDAY	8.67	3.80	4.87	56.2%
SUNDAY	7.40	3.64	3.76	50.8%
OVERALL AVERAGE	8.69	3.72	4.97	56.7%
OVERALL STANDARD DEVIATION	1.89	0.72	0.63	6.9%

Source: AIDS Log Files

TABLE 4-10

PERCENTAGES OF AIDS FUNCTIONS PROCESSED BY TYPE
(AVERAGES FOR EACH WEEK OF DATA COLLECTION)

WEEK (1981)	FUNCTION TYPE			
	ITINERARY	SCHEDULE	ROUTE	FARE
Oct. 5-11	85	11	0	4
Oct. 12-18	81	14	1	4
Oct. 19-25	84	11	0	5
Oct. 25-Nov. 1	84	10	0	6
Nov. 2-8	85	10	0	5
Nov. 9-15	85	9	0	6
OVERALL AVERAGE	83.61	11.08	0.35	5.15
ON AVERAGE, ONE CALL IN EVERY	1.20	9.00	285.70	19.41

Source: AIDS Log Files

frequently used, comprising another 11% of all transactions. Fare requests account for an additional 5%, while route description transactions are almost never selected by the agents (once out of every 286 transactions, on average). This breakdown is rather to be expected since it reflects the relative frequencies of inquiry types received overall, and since itinerary requests require the most manual research on the part of the agent, while manual schedule references are a relatively straightforward and speedy process. Agents who have undergone the full WMATA training program (all but four of the agents during the data collection period) would be expected to know most route description and fare data from memory.

- By comparing computer records to ACD readings, it is possible to make some qualified statements concerning the percentage of total calls answered for which AIDS transactions are used for data retrieval. The problem in reporting this percentage is that the computer records data only by transaction and not by call, as does the ACD system. Although the great majority of calls involve only one AIDS transaction, it is quite possible that a multiple-query call might cause the agent to process more than one valid AIDS transaction. Making the imperfect assumption, then, that one valid computer transaction equals one call processed, an upper bound can be determined for the percentage of calls which prompt AIDS usage. These percentages are presented in Table 4-11. From this table it is evident that AIDS is used more frequently during the peak demand days of the week (Monday, Tuesday and Wednesday), during which a maximum of between 25 and 30 per cent of all calls prompt computer transactions. Computer usage tapers off through the rest of the week to a maximum of approximately 17% of all calls on weekends.

TABLE 4-11

RATIO OF VALID AIDS TRANSACTIONS TO TOTAL CALLS ANSWERED
(PERCENT)

WEEK (1981)	DAY OF WEEK						
	MON	TUE	WED	THU	FRI	SAT	SUN
Oct. 19-25	32	30	28	24	22	23	20
Oct. 26 - Nov. 1	19	30	27	17	23	15	17
Nov. 2-8	30	28	23	28	14	13	17
Nov. 9-15	30	19	16	25	17	17	16
AVERAGE	28	27	24	24	19	17	18

Source: AIDS Log File

4.9 AFTER-IMPLEMENTATION CALL MONITORING

Included in after-implementation data collection efforts was an intensive three-week session of call monitoring. This monitoring was accomplished using the same techniques as had been used previously before implementation. Major objectives of this monitoring program were to:

- verify the general accuracy of computer log file data;
- supplement computer log file data concerning call types received and agent performance in answering them;
- provide measurements for data retrieval and total call times, items which were explicitly missing from both ACD and computer log file data.

Data items recorded in this after implementation call monitoring effort included the following:

- Day and date;
- ID number of operator monitored, and whether or not the operator had received AIDS training;
- Call type (itinerary, schedule, route or fare);
- Data retrieval time (the elapsed time between the end of the caller query and the beginning of the agent response);
- Mode of data retrieval selected by the operator (manual only, AIDS only, memory, or a mixture of the above);
- Total call time (the elapsed time from the operator's initial greeting to final caller disconnect);
- Qualitative observations regarding any perceived call circumstances that might have affected other data collected.

Calls were monitored from November 23 to December 11, 1981. During this time, a total of 1,341 calls were successfully documented. From this documentation, frequencies of important variables were calculated and cross-tabulations were produced for certain data items of interest. These results are described below:

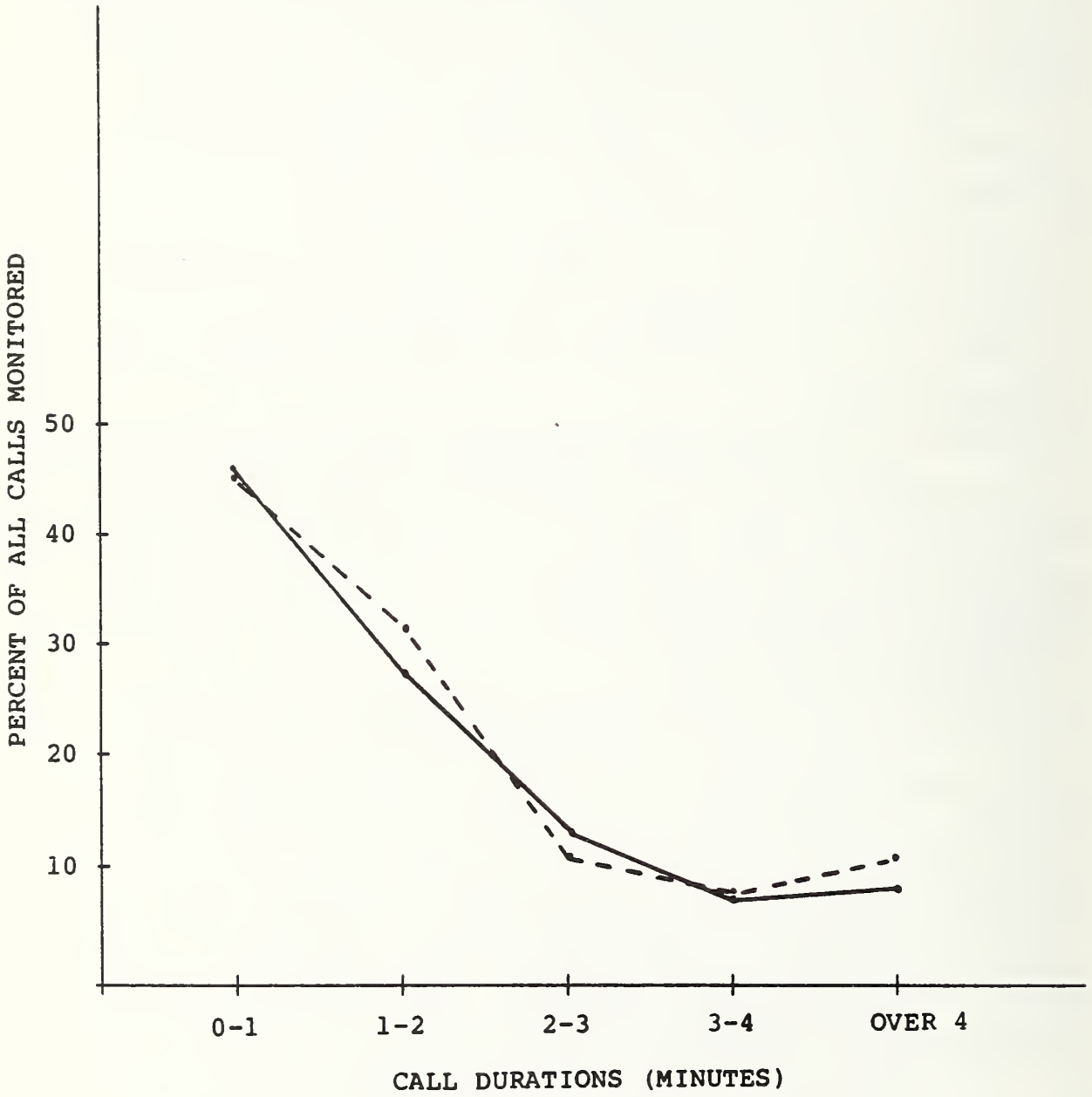
- Call types recorded were generally consistent with pre-implementation monitoring results. Once again 886, or 66% of

all calls monitored, involved itinerary requests. An additional 373, or 27% of the total, involved schedule information queries, while fare queries were mentioned in 81, or 6% of all calls. Route and other queries were mentioned only in one instance or less than 1% of the calls monitored.

- Agents used manual data retrieval exclusively in 699, or 50.6% of all calls monitored. AIDS was used exclusively in handling an additional 316 calls, or 23.6% of all calls. Agent memory (no reference to either AIDS or manual materials) was used in 188, or 14% of all calls, while agents used a mixture of the retrieval modes in the remaining 158 instances, or 11.8% of the total. Since about half of these mixed-mode retrievals involved AIDS, the retrieval breakdown is consistent with the 25-30% AIDS use breakdown derived from comparing computer log and ACD data.
- Computer retrieval times recorded in the monitoring process averaged between 15 and 20 seconds, although occasionally longer times were reported. This sample, however, was generated during a peak period of caller input and AIDS use and therefore can be considered an "upper limit" on AIDS processing time.
- Total call times observed in the after monitoring effort are relatively similar to those observed pre-implementation. A total of 611 calls, or 45.6%, lasted one minute or less. An additional 361, or 26.9%, had durations between one and two minutes. A total of 194 calls, or 14.5%, took between two and three minutes to complete, while 86, or 6.4%, lasted between three and four minutes. Only 89, or 6.6%, lasted over 4 minutes. This frequency distribution is illustrated in Figure 4-4; it is compared in this figure with the pre-implementation distribution shown previously in Figure 4-2.

FIGURE 4-4

FREQUENCY DISTRIBUTION OF CALL TIMES,
BEFORE (DOTTED LINE)
AND AFTER (SOLID LINE) IMPLEMENTATION



Source: WHA Call Monitoring

- A cross-tabulation was made of call times against retrieval mode used. This tabulation is shown in Table 4-12. As can be seen from this cross-tabulation, manual retrieval-only calls are generally of short durations; 85% of these calls take less than two minutes to complete, while 61% take less than one minute. AIDS-only and mixed-mode calls have flatter time distributions, and average around two minutes in duration. As might be expected, the great majority (77%) of memory-only calls take less than one minute, since they require no data retrieval time.
- Table 4-13 depicts a cross-tabulation of query type versus mode of data retrieval chosen. As can be seen from this table, the vast majority (85%) of schedule queries prompt agents to use manual retrieval. On the other hand, 84% of all AIDS-only calls are itinerary requests.
- In Table 4-14, a cross-tabulation of call time vs. query type is presented. This table reinforces the finding that schedule requests are generally handled in rapid fashion, while itinerary and fare requests usually take longer.

4.10 AFTER IMPLEMENTATION AGENT QUESTIONNAIRE

The design of the after-implementation agent questionnaire, which was administered during November-December 1981, was very similar to that of the before-implementation questionnaire. A total of 12 questions were asked of agents across a broad range of topics regarding the impacts of AIDS on their work. Of these, eleven were multiple-choice and three provided blanks for open-ended responses on the part of the agents. A total of 26 questionnaires were returned for analysis. Frequencies for each response as well as several cross-tabulations were produced; results are presented below.

TABLE 4-12

CROSS-TABULATION OF CALL TIME VS DATA RETRIEVAL MODE
AFTER IMPLEMENTATION CALL MONITORING

CALL TIME (SECONDS)	MODE OF DATA RETRIEVAL				TOTAL
	MANUAL ONLY	AIDS ONLY	AGENT MEMORY	MIXTURE OF MODES	
0 - 30	180	5	82	7	274
30 - 60	235	21	63	18	337
60 - 90	115	63	20	22	220
90 - 120	51	56	11	23	141
120 - 180	66	88	8	32	194
180 - 240	19	37	2	28	86
240 - 300	8	26	2	12	48
300 - 360	2	14	0	7	23
Over 360	3	6	0	9	18
TOTAL	679	316	188	158	1341
PERCENT OF TOTAL	50.6	23.6	14.0	11.8	

TABLE 4-13

CROSS-TABULATION OF QUERY TYPE VS RETRIEVAL MODE CHOSEN AFTER IMPLEMENTATION CALL MONITORING

QUERY TYPE	MODE OF DATA RETRIEVAL				TOTAL
	MANUAL ONLY	AIDS ONLY	AGENT MEMORY	MIXTURE OF MODES	
ITINERARY	325	264	164	133	886
SCHEDULE	316	31	14	12	373
ROUTE	0	1	0	0	1
FARE	38	20	10	13	81
TOTAL	679	316	188	158	1341

TABLE 4-14

CROSS-TABULATION OF CALL TIME VS QUERY TYPE
AFTER IMPLEMENTATION CALL MONITORING

CALL TIME (SECONDS)	QUERY TYPE				TOTAL
	ITINERARY	SCHEDULE	ROUTE	FARE	
0 - 30	116	140	0	17	273
30 - 60	195	144	0	25	364
60 - 90	140	43	0	13	196
90 - 120	115	25	0	7	147
120 - 180	156	12	0	13	181
180 - 240	77	6	0	5	88
240 - 360	68	2	1	1	72
Over 360	19	1	0	0	20
TOTAL	886	373	1	81	1341
PERCENT OF TOTAL	66.07	27.81	.08	6.04	

- To the question, "How long have you worked as an information agent?", one agent replied "7-12 months", 7 replied "one to two years", 4 replied "two to three years", and 14 replied "over three years". Thus the respondents averaged at least 2.2 years on the job. These experience responses are compared with before-implementation survey responses to the same question in Table 4-15. From this table, it can be seen that the respondents to the after-implementation survey were generally more experienced than the before-implementation group.
- In response to the question "How long have you been using AIDS?" 14 replied "6 or more months", 9 agents replied "3 to 6 months", and 3 responded "less than 3 months". Thus the sample was also well experienced, for the most part, in AIDS use.
- To the question "What is your hourly call count under busy conditions?" Four agents chose the response "16-20", nine chose "21-25", 10 chose "26-30", and three chose "over 30". This distribution works out to an average of at least 23 calls per hour. This distribution of responses is quite similar to that of the before-implementation survey, as shown in Table 4-16.
- Agent perceptions as to how AIDS use affected their call counts were of particular interest. In the questionnaire, a total of 12 agents responded that AIDS use reduced their call counts; 8 agents responded that AIDS increased theirs, and 6 more agents responded that their call counts remained the same. This rather negative result came as something of a surprise to WMATA supervisory and management personnel, who had well-documented evidence through routine call monitoring and spot performance checks on agents that call counts did initially drop following AIDS training, but soon regained normal or higher levels once computer proficiency, including typing skills and manipulation of keyboard functions, was achieved. Analyzing

TABLE 4-15

COMPARISONS OF AGENT RESPONSES TO SURVEY QUESTIONS REGARDING JOB EXPERIENCE

BEFORE AND AFTER AIDS IMPLEMENTATION

EXPERIENCE AS AN AGENT	TOTAL RESPONSES		% OF TOTAL	
	BEFORE	AFTER	BEFORE	AFTER
0 - 6 MO.	3	0	7	0
7 - 12 MO.	8	1	19	4
1 - 3 YRS.	13	7	31	27
3 - 5 YRS.	9	4	21	15
OVER 5 YRS.	9	14	21	54

TABLE 4-16

COMPARISONS OF AGENT RESPONSES TO SURVEY QUESTIONS
REGARDING HOURLY CALL COUNTS

BEFORE AND AFTER IMPLEMENTATION

CALL COUNT PER HOUR AS REPORTED BY AGENT	TOTAL RESPONSES		% OF TOTAL	
	BEFORE	AFTER	BEFORE	AFTER
0 - 15	2	0	5	0
16 - 20	5	4	12	15
21 - 25	15	9	36	35
26 - 30	12	10	29	38
OVER 30	8	3	19	12

the 12 negative responses further, it can be seen that half of these agents had been using AIDS for less than 6 months. Additionally half (although not the same six) responded that they used the system only "a few times a day". Thus, the agents responding to the after-implementation survey may not have been entirely representative of the total agent work force as regards the influence of AIDS on productivity.

- To the question "How often do you use AIDS?", 8 agents responded "few times a day", 15 responded "over 1/2 my calls", and 2 responded "almost every call".
- Nine agents chose the response "excellent" to rate their ability using AIDS. An additional 15 rated their ability as "good", while 2 chose the "fair" response. None of the agents rated themselves "poor" in this category.
- Agents had a fairly good opinion of AIDS training. A total of 22 agents rated their training as "just right", while only three claimed that there was "much more training than was necessary", and only one selected the response "training was not enough".
- In rating their overall job satisfaction, six agents chose "excellent" as a response, while 16 chose "good" and four chose "fair". None of the respondents chose the "poor" response. These responses are very similar to those of the before-implementation survey, as shown in Table 4-17.
- To the question "In what way has learning to use AIDS influenced your job satisfaction?" agents gave the system an overwhelming vote of confidence. A total of 19 agents chose "in a positive way", six more chose "no influence", and none chose "in a negative way". These responses are compared with agent perceptions of AIDS influence before implementation in Table 4-18. From this table, it can be seen that "negative" feelings towards AIDS have been reduced following implementation.

TABLE 4-17

COMPARISONS OF AGENT RESPONSES TO SURVEY QUESTIONS REGARDING JOB SATISFACTION

BEFORE AND AFTER IMPLEMENTATION

AGENT SELF-RATING OF SATISFACTION	TOTAL RESPONSES		% OF TOTAL	
	BEFORE	AFTER	BEFORE	AFTER
EXCELLENT	7	6	17	23
GOOD	24	16	57	62
FAIR	10	4	24	15
POOR	1	0	2	0

TABLE 4-18

COMPARISONS OF AGENT RESPONSES TO QUESTIONS
REGARDING AIDS INFLUENCE ON THEIR JOBS

BEFORE AND AFTER IMPLEMENTATION

IMPACT CATEGORY CHOSEN BY AGENT	TOTAL RESPONSES		% OF TOTAL	
	BEFORE	AFTER	BEFORE	AFTER
POSITIVE	34	19	83	76
NO CHANGE	2	6	5	24
NEGATIVE	5	0	12	0

- To the question "What aspect of AIDS causes you the greatest problem?", agents were provided four choices plus a blank labeled "other" for agents to supply their own comments. Two agents chose the response "choosing which function to use", three agents chose "typing in caller information", and 12 chose "completeness/accuracy of responses". A total of 7 agents provided comments under "other". Of these, four mentioned problems with "sectors"* and three criticized the slowness of system responses.
- Agents were asked to compare AIDS with manual information processing across a broad range of categories. Agent responses are summarized in Table 4-19. From this table, it can be seen that agents are, on the whole, quite favorably disposed to the system. The AIDS system was rated "better" in 97 agent responses, or 53.3% of the total, and "about the same" in an additional 67 responses, or 36.8%. Only 13 responses characterized AIDS as "worse" than manual (7.1% of the total). Particularly strong positive showings for AIDS came in the categories of "detail of information" and "making job easier". The strongest negative comparison came under the category "speed of retrieving information", in which 16 agents felt manual was about the same or better than AIDS.
- For the question "How can AIDS be improved to help you in your work?" only a blank was provided for open-ended agent responses. A number of interesting suggestions were made by agents, highlighting some of the weaknesses of the system in its present form.

---

*The AIDS geographic data base is divided into sectors based on political boundaries in the D.C. metropolitan area. The "Sector" input must be correct before the computer is able to locate address inputs This "Sector" input is a leading cause of agent "errors."

TABLE 4-19

AGENT COMPARISONS OF AIDS VS MANUAL DATA RETRIEVAL METHODS
AFTER IMPLEMENTATION AGENT SURVEY

COMPARISON CATEGORY	AGENT RESPONSES		
	AIDS BETTER THAN MANUAL	AIDS WORSE THAN MANUAL	AIDS ABOUT THE SAME AS MANUAL
SPEED	9	6	10
ACCURACY	11	2	11
DETAIL	20	1	5
JOB FATIGUE	9	1	15
MULTIPLE QUERY	14	2	9
MAKE JOB EASIER	20	0	6
CALLER SATISFACTION	14	1	11
TOTAL	97	13	67
% OF ALL RESPONSES	53.3	7.1	36.8

The most frequent agent suggestion was that the speed of the system be improved, especially for schedule requests. From the call monitoring data, it would seem as though agents presently handle most schedule requests manually, because manual retrieval is in most instances faster.

Other agents suggested expanding the "time window" of schedule function responses. At present, all scheduled runs for a given route are displayed on the response screen for the two-hour period beginning one hour before and ending one hour after the reference time entered by an agent. Agents would like to see this "window" increased to 4 or more hours if possible, or for the function to include a "scrolling" capacity so that the time window could be manipulated by the agent. A related suggestion was for the development of a "last bus" function. To determine what time the last scheduled bus of the day passes a given location, the agent must guess a time reference point which is likely to include the last bus within its two-hour "window". For example, suppose a given bus route passes a certain scheduled stop at 35 minutes past the hour every hour until 12:35 a.m. If an agent entered 11:30 in the schedule function for that particular stop, the last bus at 12:35 would not appear on the response screen. With the long headways for most runs late at night, a two-hour "window" is considered by most agents to be insufficient.

Another frequent suggestion was for development of a "nearest stop" function. The system is programmed to search for stops within a 1/2 mile of a given input address. If no stops are found, the computer produces an "error" message and the agent is forced to remanipulate the address input. Agents feel that the capacity to manipulate the

system's "searching radius" would be more effective, especially for remote suburban addresses where stops are likely to be widely spaced.

The present system of landmarks in the geographic data base was the subject of criticism by several agents. Since these landmarks were added incrementally over the course of system implementation, they are not standardized, and agents must therefore memorize their correct spelling (or abbreviation) to ensure recognition and verification by the system.

A final suggestion was made concerning development of a "forcing" function. Using such a function, an agent could "force" the computer to search out itineraries using a stated bus line, even if that line did not make the minimum-time itinerary. Agents occasionally encounter customers who are familiar with a certain bus line or route and who do not want to change their transit habits even if such a change would make their trip shorter or more economical.

Tables 4-20, 4-21 and 4-22 are all cross-tabulations which were produced from the agent questionnaire results. Of particular interest in these cross-tabulations were the rather negative responses to the "AIDS influence on hourly call count" question; these form one of the variables in each cross-tabulation.

Table 4-20 presents AIDS influence on call count versus the frequency of AIDS use. This table supports the intuitive notion that agents who felt that AIDS increased their call count tend to use it more frequently than those who did not.

Table 4-21 presents overall agent experience versus AIDS influence on call count. From this table, it can be seen that agents with less experience tended to feel that AIDS increased their call counts, while more experienced

TABLE 4-20

CROSS-TABULATION OF AIDS INFLUENCE ON CALL COUNT
VS FREQUENCY OF AIDS USE
AFTER IMPLEMENTATION AGENT SURVEY

AIDS INFLUENCE ON CALL COUNT	FREQUENCY OF AIDS USE			TOTAL
	FEW TIMES A DAY	OVER HALF OF CALLS	ALMOST EVERY CALL	
REDUCTION	6	5	1	12
ABOUT THE SAME	1	4	1	6
INCREASE	1	6	0	7
TOTAL	8	15	2	25

TABLE 4-21

CROSS-TABULATION OF AGENT JOB EXPERIENCE
VS PERCEPTION OF AIDS INFLUENCE ON CALL COUNT
AFTER IMPLEMENTATION AGENT SURVEY

AGENT JOB EXPERIENCE	PERCEPTION OF AIDS INFLUENCE ON CALL COUNT		
	REDUCTION	SAME	INCREASE
7 - 12 MO.	0	0	1
1 - 2 YRS.	1	1	5
2 - 3 YRS.	2	2	0
OVER 3 YRS.	9	3	2
TOTAL	12	6	8

TABLE 4-22

CROSS-TABULATION OF AIDS EXPERIENCE VS PERCEPTION OF AIDS INFLUENCE ON CALL COUNT

AFTER IMPLEMENTATION AGENT SURVEY

AIDS EXPERIENCE	AIDS INFLUENCE ON CALL COUNT			TOTAL
	REDUCTION	SAME	INCREASE	
0 - 3 MOS.	1	1	1	3
3 - 6 MOS.	5	2	2	9
OVER 6 MOS.	6	3	5	14
TOTAL	12	6	8	26

agents (with 3 or more years on the job) tended towards the opposite opinion. This result may be viewed as rather discouraging, but as discussed above, survey respondents might not be wholly representative of the agent work force.

Table 4-22 plots AIDS experience versus AIDS influence on call count. From this table, it is evident that AIDS experience has little influence on perceptions of call count influence.

5.0 CONCLUSIONS

5.1 BEFORE-AFTER DATA COMPARISONS

The various quantitative and qualitative data collected at WMATA Telephone Information Section and detailed in the previous chapter permit a number of "before-after" comparisons to be made concerning caller demands and agent and system performance in meeting these demands. It should be remembered, however, that AIDS implementation is not the single contributing factor to any changes that might be observed in these data. The Telephone Information Section is not a laboratory in which all external forces can be controlled. Three other major changes have also had an influence on Section operations:

- The Section has experienced a relatively high turnover rate. The position of information operator is considered entry-level on the WMATA pay scale, and many operators use it as a stepping stone to higher paying positions elsewhere in the Authority. This turnover has had the effect of lowering the average job experience for the Information Section, a factor which may be detrimental to its overall performance since agents and management agree that productivity increases with job experience.
- Customer demand is inherently variable, and exhibits seasonal changes over the course of the year in much the same way it varies from day to day over the course of the week.

- Implementation of AIDS included the construction of an entirely new workspace for the information operators. WMATA management personnel indicated in interviews that system performance and agent job satisfaction were enhanced to a considerable degree by these new surroundings.

Several "before-after" comparisons have already been presented in Figures 4-3 and 4-4 and Tables 4-15 through 4-18. The discussion below presents several further comparisons based on the data collected before and after implementation.

- ACD data: In the before-implementation period, ACD readings show that the Information Section received an average of 6813 calls. Of these, 6162, or 90.4%, were answered on average. In the after-implementation period the Section received an average of 5966 calls and answered an average of 5126, or 85.9% of the daily total. Thus overall caller demand declined 12.4% between the two periods, while calls answered declined an even larger 16.8%. Overall system productivity thus declined 4.4%. This reduction might be explained in part by agent turnover and by the demand variation factors described above. It might also be explained by the relative newness of the system to agents while after-implementation performance data were being recorded. It is probable that overall productivity would improve with increasing agent familiarity with the system. Nevertheless, demand patterns over the course of the week remained very stable over the course of system implementation, as shown previously in Figure 4-3. Based on these data, the implication is that little has been accomplished by system implementation towards the reduction of the "lost call" rate of 10 - 15 percent of all incoming calls.
- The first and second columns of Table 5-1 present data on call content as determined by call monitoring before and after implementation. As can be seen from this data, percentages of various call types remained remarkably

TABLE 5-1

CALL TYPE FREQUENCIES BEFORE AND AFTER AIDS IMPLEMENTATION

CALL TYPE	FREQUENCY OF OCCURRENCE, %		
	BEFORE IMPLEMENTATION	AFTER IMPLEMENTATION	COMPUTER LOG FILE
ITINERARY	66	66	84
SCHEDULE	24	27	11
ROUTE	7	0	0
FARE	3	7	5

Source: WHA Call Monitoring,
AIDS Log File

constant over the implementation period. It is interesting to compare these data with call type percentages handled by the computer, as shown in the third column of Table 5-1. These computer data show that agents use the computer for a disproportionately high number of itinerary-type calls, and for a correspondingly lower number of schedule-type call. Call monitoring results showed that schedule-type calls were generally handled fastest manually even after implementation. Hence, these data are consistent with this observation. (See Table 4-13.)

- Data on call times collected before and after implementation are presented in Table 5-2. This table shows an increase of 3.5% in calls answered in one minute or less, although the percentage of calls handled in three minutes or less is unchanged. Considering the stated objective of system implementation to increase agent productivity, this result is rather discouraging.
- Data sources consulted as reference materials were substantially changed by AIDS implementation. Before and after implementation data concerning these sources are presented in Table 5-3. This table indicates that the frequency of "top of head" responses (no reference materials consulted) remained fairly constant at approximately 15% of total calls throughout the implementation period. The computer, however, has replaced manual data for between 25 and 30 percent of all calls referenced.
- Agent questionnaire results before and after implementation generally indicate a high degree of agent support for AIDS, particularly in the area of "making job easier". This support is tempered somewhat by frustration regarding response speed, especially for schedule-type questions. Few agents reported experiencing problems anticipated in the before survey in adjusting to AIDS, including typing and scanning the CRT screens.

TABLE 5-2

CALL TIME FREQUENCIES BEFORE AND AFTER AIDS IMPLEMENTATION
(PERCENT OF ALL CALLS ANSWERED)

CALL TIME (SECONDS)	BEFORE IMPLEMENTATION	AFTER IMPLEMENTATION	DIFFERENCE
0 - 60	42.1	45.6	+3.5
60 - 120	31.7	26.9	-4.5
120 - 180	13.2	14.5	+1.3
180 - 240	5.4	6.4	+1.0
OVER 240	7.6	6.6	-1.0

Source: WHA Call Monitoring

TABLE 5-3

DATA SOURCES CONSULTED BY AGENTS
BEFORE AND AFTER AIDS IMPLEMENTATION

(FREQUENCY OF USE, PERCENT)

DATA SOURCE	BEFORE IMPLEMENTATION	AFTER IMPLEMENTATION	DIFFERENCE
MANUAL ONLY	85.4	50.6	-34.8
COMPUTER ONLY	*	23.6	+23.6
MIXTURE OF SOURCES	*	11.8	+11.8
AGENT MEMORY	14.6	14.0	-.6

* Did not exist before implementation

Source: WHA Call Monitoring

5.2 SUCCESS OF AIDS IMPLEMENTATION

A review of the above comparisons, supplemented by other performance data reported in the previous chapter, leads to generally mixed findings concerning the success of AIDS implementation. While system development and debugging took longer than anticipated, the spirit of cooperation between system designers and system users throughout this process has ensured its eventual usefulness. Without this cooperation, it is highly unlikely that AIDS would be used as a data source with nearly the frequency that it is today. Although there are still a few minor unresolved problems, it can be stated that AIDS is currently being used as system designers and WMATA management intended. The anticipated benefits of AIDS implementation, as stated earlier, were:

- improved productivity in terms of agent calls per hour answered due to faster data retrieval;
- increased reliability and consistency of agent responses;
- a reduction in training time for new agents;
- improved capability to rapidly incorporate changes in transit agent reference data;
- enhancement of the agent's overall job satisfaction;
- expanded capability to gather statistics concerning individual agent and Information Section performance;
- use of the transit system data base by other WMATA departments as a planning source.

The remainder of this Section discusses the achievement to date of AIDS deployment in each of these anticipated benefit areas. As might be expected, data collected regarding each area has occasionally produced ambiguous results. In the following paragraphs, a number of conclusions are drawn concerning anticipated AIDS benefits.

- Agent Productivity: Data collected during the course of the evaluation lead to conflicting conclusions regarding system influences on agent productivity.

Agents were evenly divided on the after-implementation questionnaire regarding AIDS' influence on call counts, and a number of them complained about system response speed. Furthermore, ACD data revealed an overall decrease in Information Section productivity (in terms of calls lost) post-implementation. In contrast, agents were almost unanimous on the after-implementation survey in the opinion that AIDS made their jobs easier, and routine performance tests conducted by WMATA management reveal that operators using AIDS are capable of answering calls at the rate of 30 to 40 per hour, a 30% increase over their usual manual speed.

WMATA supervisory and management personnel were able to shed some light on the causes underlying these conflicting results. It appears that given current system response speeds, customer schedule questions are still handled fastest manually; this fact is supported by the after-implementation call monitoring data (see Table 4-13). Thus, agents who use the computer for nearly every call are actually less productive overall than those who use it more selectively (i.e., who handle schedule requests manually). Varying agent experience levels are also a contributing factor to lower post-implementation productivity, since newer agents tend to rely on computer or manual references more than their more experienced counterparts, who rely more on memory. The Information Section experienced considerable turnover in personnel during system implementation. Supervisory personnel indicated that very experienced operators (having 10 or more years on the job) are able to respond to 75% of their calls from memory. These operators tend to use AIDS only for calls requiring construction of long or complex itineraries. It is not surprising, then, that the more experienced operators would feel

that using the computer would slow them down in most instances, since memory responses are shorter than AIDS consultation, but would still be of the opinion that it made their jobs easier (for the more complex questions).

Supervisory personnel indicated that they were initially discouraged by agent call counts following AIDS training. When it was made clear to the agents that using AIDS was not necessarily the most useful or efficient way to respond to every call, productivity increased considerably, usually to levels above previous averages for manual data retrieval. Management and supervisors both felt that a 50-50 balance between computer and manual data retrieval produced the highest overall call count for the average agent. Monitoring data show that this balance has not yet been achieved; the computer is currently used for only 25-30% of all calls.

Certain system improvements are currently being contemplated that may have a strong positive impact on the ambiguous productivity results discussed above. They are:

-- Hardware improvements to increase system capacity and decrease system response time.
-- Improvements to the "schedule" function which would make the information displayed for a typical response much more comprehensive than the information now produced and comparable to that currently available from a manual reference.

- Response Accuracy and Consistency: The agents felt that AIDS responses were more accurate and had a greater level of detail than manual responses (see Table 4-15). Supervisory personnel stated that the problem of misinformation, while affecting a relatively small percentage (1-2%) of all calls answered, was greatest with inexperienced operators using manual materials only.

Supervisors indicated that they felt much more comfortable when these operators consulted AIDS.

A feature of AIDS that helps ensure the nearly 100% accuracy of its data base is the built-in error-reporting function. If an operator receives a response that he/she deems questionable, activating the reporting function will cause the response to be listed, along with the agent's ID number, on a daily "trouble report". A review of this report by agents and management helps to locate inconsistencies or errors in the data base, as well as to identify areas in which an agent's training might be deficient. It cannot be overemphasized that this enhancement process is an interactive one in which agents and Information Section management are active participants. This interaction not only results in greater accuracy of the data base and a more workable system, but also leads to increased confidence on the part of the agents that they are personally responsible for system accuracy.

- Agent Training: Interviews with Information Section management indicated that the the anticipated benefit of reduced training time for operators does not appear to be achievable, based on results with four new agents. These agents received a two-week course which included computer manipulation practice, communications skills development, and some rudimentary background in use of manual references (they already possessed typing skills). They were not given the intensive geographic and transit system practice which forms a major part of the traditional 6-week manual training period. After two weeks, these agents were producing "acceptable" call counts of 80-90 per day, and it seemed to management as though the training reduction benefit had been achieved.

Reports from supervisory personnel, however, soon produced strong evidence to the contrary. Without the geographic and transit system practice of the standard training course, these new agents were unable to provide details to callers concerning landmarks to use as reference points on their journeys. Even worse, they were unable to make interpretive judgements as to which of the four feasible alternative responses routinely produced by AIDS best suited the caller's request. In the opinion of the supervisors, they became too dependent on the computer for "simple" questions, such as fare and schedule requests, which other agents would have handled manually or from memory. To remedy these observed deficiencies in their performance, these agents were later given additional training emphasizing map work and manual schedule practice. With this additional training, these agents were better able to picture routes, intersections, and landmarks, and achieved full proficiency (150-170 calls per day).

The net result of this experience was to point out that agents with AIDS training, but lacking a good foundation in manual practice and geographic data manipulation, are of marginal value. While these operators could be used as a stopgap measure during periods of critical manpower shortage, their long-term usefulness is limited.

- Updating of Data Base: It is important to recognize that the geographic and transit data bases, once established, are not static. Rather, they must be constantly changed to reflect changes in local land use and in transit service. Making these changes requires the full-time effort of one WMATA employee. They are made so frequently that the AIDS geographic data base is becoming recognized as the most accurate address directory available for the Washington, D.C. metropolitan area.

While theoretically the transit data base updates could be made in the same centralized fashion as the geographic updates and copies printed by the AIDS computer for manual use, this does not happen in practice. Instead, word processing equipment in the Scheduling Department of WMATA (installed during AIDS implementation) is used to produce the hard copy manual data base materials, and several clerks work full-time to keep these manual references updated. So long as implementation of AIDS is mixed (that is, manual as well as computer data referencing is available) there will be little cost savings from centralized data base updating. No shift away from the mixed operation is contemplated in the near future. Thus actual cost reductions due to centralized data base updating have not been achieved, although the process for generating hard copy schedule data and other manual references has been streamlined somewhat through the introduction of word processing equipment.

- Agent Job Satisfaction: All data collected during the evaluation on the subject of AIDS' influence on agent job satisfaction point to the fact that AIDS was well-received by agents. In the before-implementation survey, 73% of agents responding chose "excellent" or "good" to describe their job satisfaction; in the after-implementation survey this percentage had risen to 85%. On the after-implementation questionnaire, agents were asked to rate the influence of AIDS on their job satisfaction. To this question, 76% replied "positive influence" and the remainder replied "no influence". None of the responding agents responded "negative influence".
- Data Collection: The AIDS software as implemented contains a number of features which enhance system usefulness as a data collection tool. These features are routinely used at present by supervisory and management personnel

to monitor individual agent as well as system performance. Since implementation, there has been a dramatic increase in both the quantity and quality of these performance data. Unfortunately, however, some items are still lacking, because AIDS stores information concerning computer transactions only, and manual calls remain undocumented. Consideration might be given to modifying system software in such a way that a more detailed version of ACD data could be transmitted to AIDS and stored directly from the ACD equipment. In this way, all calls would be fully documented, and supervisors would be relieved of the job of recording ACD data manually from the "peg counter" apparatus.

- Interdepartmental/Spinoff Use: AIDS implementation has raised potentials for interdepartmental cooperation within WMATA on a scale not heretofore realized. Examples of cooperative efforts which have already been achieved are as follows:
  - -- The WMATA Scheduling Department had benefited from standardization and storage of its data on word processing equipment. While this standardization and storage effort was a necessary expenditure for the establishment of the AIDS transit data base, the Scheduling Department continues to enjoy cost savings each time schedules are updated. Since this process is ongoing these savings will continue indefinitely.
  - -- The AIDS transit data base was used as a resource by the WMATA Planning Department in the recent implementation of the RUCUS run-cutting and driver scheduling system. It is estimated that having this transit data fully organized saved WMATA over $50,000 in implementation costs for RUCUS.

Examples of potential future benefits of AIDS are as follows:

-- The WMATA Planning Department could make use of the AIDS Daily Log File as a planning rescurce. For example, origins and destinations of all itinerary calls could be superimposed against a system route map to determine whether service is adequate in areas with high information demand. Frequency of demand for information on certain bus routes could also be compared with frequency of service on these routes.

-- The WMATA Bus Stop Department could make use of AIDS in its ongoing program of providing information on MetroBus Stops. AIDS data can be used to document which bus routes pass by a given stop.

-- The WMATA Accounting and Finance Department could use the AIDS transit data base as a resource in calculating the number of passenger route-miles provided by WMATA to each of the numerous local jurisdictions in the service area. Using the data base in this fashion would greatly simplify these calculations, which form one basis for WMATA's operating subsidy assessments. Given alternative assumptions on route and service level changes, the data base can also be used as a financial forecasting tool to show the effects of proposed service changes.

AIDS implementation has also raised the potential for other non-WMATA agencies to make use of the system. Examples of such "spinoff" possibilities are:

-- Use of the geographic data base by the Federal Government or other jurisdictions as a resource in shared-ridership or car pool assignment programs.

-- Provision of the geographic data base as a planning resource to local governments. It is generally recognized that this data base is the most accurate

street address directory of the Washington, D.C. metropolitan area currently in existence. The D.C. Council of Governments has already expressed a willingness to pay for use of this geographical data base.

-- Provision of remote AIDS terminals at local transportation centers for use by the general public. Such centers might include the major METRO stations, National and Dulles Airports, local universities, etc.

Thus, the implementation of AIDS and the concomitant establishment of its various data bases have created a significant resource which has a strong potential for serving a number of users besides WMATA information operators and callers. The overall financial justification of the system is therefore far greater than merely productivity increases and cost savings within the WMATA Office of Marketing. According to the AIDS Program Manager, the benefits created by AIDS have already greatly outweighed its overall cost to the Authority.

In conclusion, while the AIDS system is not without faults, it is fair to say that it has already achieved some of its intended benefits. The process of system enhancement and improvement continues with the support and confidence of WMATA management and system users. Bringing the system to its present status required dedication and hard work on the part of system designers, WMATA management, and the information operators. One agent's final comment on the After-Implementation Agent Questionnaire very accurately summarizes the prevailing sentiment about AIDS. "The system has proven to me to be a very useful mechanism. The only improvements I would suggest would be faster response times and sometimes not giving so many alternatives. Otherwise, Bravo Machine!!!"

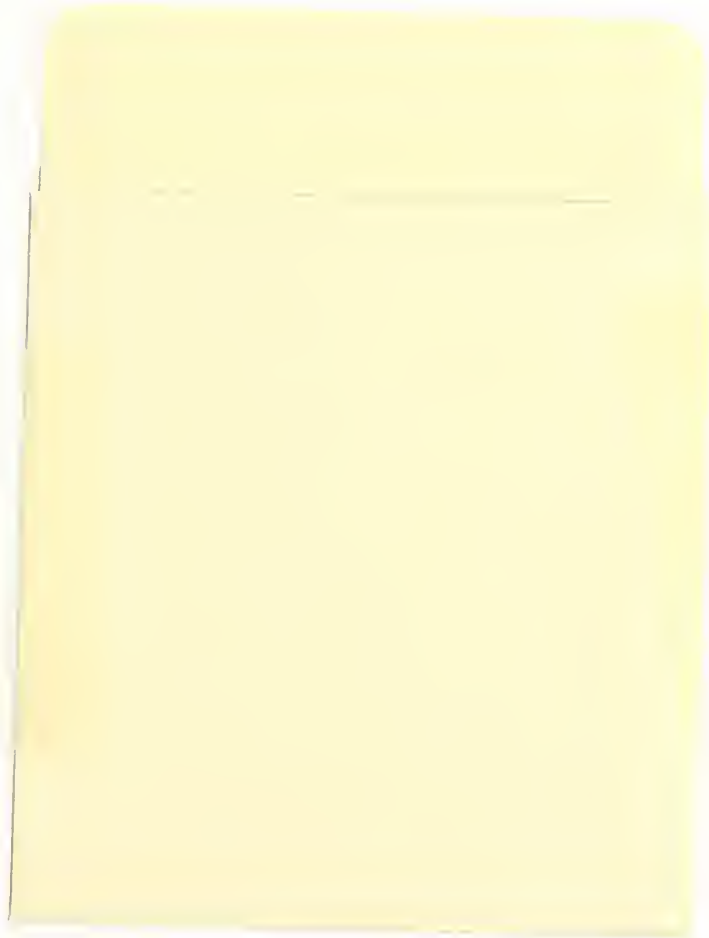
APPENDIX A

REPORT OF NEW TECHNOLOGY

WMATA - AIDS EVALUATION

This report documents a series of data collection efforts undertaken by Wilson Hill Associates at the Telephone Information Center of the Washington, DC Metropolitan Area Transit Authority (WMATA) during 1980 and 1981. The focus of these efforts was a socio-economic evaluation of the impacts of automated transit information systems (ATIS) technology, in which state-of-the-art computer systems are introduced for data retrieval in an environment where this retrieval was heretofore accomplished manually by trained telephone operators. For the first time, a before-after implementation design was employed to collect information on the impacts of ATIS technology. Key variables of interest in this assessment were operator call productivity, operator job satisfaction and working attitudes, changes in jobstyles and center operations wrought by automation, accuracy and consistency of operator information, and cost savings attributable to automation.

200 copies



U.S. Department
of Transportation

**Research and
Special Programs
Ad ion**

Kenc
Cam chusetts 02142

Official Business
Penalty for Private Use $300

Postage and Fees Paid
Research and Special
Programs Administration
DOT 513